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VIEW FROM THE SERPENTINES NEAR SAVAGLIA.—[See page 184.]

Lord Lister*

The Greatest Benefactor to Suffering Humanity

By Dr. W. Watson Cheyne

By the death of Lord Lister, the world has lost one of its greatest men, and one who, without any question, conferred more benefits on humanity than any man had ever done before. His great achievement was no doubt the revolution which he carried out in the science and practice of surgery by his investigations into the causes of septic disease, and one has only to look back at the state of surgery up to the time when he began his work to gain some idea of the enormous advance which followed.

From the earliest ages the fatal consequences of wounds, whether occurring accidentally or as a result of an operation, have occupied the minds of all those who had to do with their treatment, and all sorts of attempts have been made to obviate these evils. The practice of the ancient writers was not to keep away noxious agents which interfered with the healing of wounds, as was Lister's conception, but to *make* the wound heal, and substances were applied to *make* the flesh grow, others to *make* the growing flesh firm, and others again to *make* the wound cicatrise. Amid these attempts, the tendency of the wound itself toward healing was almost entirely lost sight of; nevertheless, there were surgeons who, from time to time, were bold enough or had insight enough to protest against these views and to point out that it is to nature itself that one must attribute the ultimate healing of the wound. However, but little attention was paid to these writers, and the practice of treating the supposed poisonous state of the surface of the wound and of inducing healing by various applications still held its own.

Paracelsus was the first who came near the modern ideas; he supposed that there is a juice distributed in the body which keeps the various tissues in good health and repairs them when injured, and he held that the whole aim of the surgeon ought to be to prevent alterations in this liquid, these alterations resulting mainly from contact with air. Medical applications are only of use in so far as they preserve this juice and prevent its corruption.

Similar views were held by Ambrose Pare, and it was chiefly by the writings and teachings of these two men that the position of nature as an agent in healing wounds was more fully recognized. The tendency after that time was to look on the contact of the air with the wound as the source of the main trouble, and after the chemical constitution of the air was discovered, it was the oxygen in the air which was chiefly blamed for the decomposition which took place in the wounds; indeed, this view was still held very widely when Lister began his researches on the prevention of sepsis.

The first result of these views was that enormous quantities of dressings were applied over the wounds and left unchanged for a long time, with a view of excluding the air. At the end of the eighteenth century and the beginning of the nineteenth, other methods of treatment were employed, which yielded very much better results than the older ones. One of the earliest of these methods was simple water dressing, and this was followed by irrigation, by the use of the water-bath, and in some cases by the addition of various antiseptic substances to the water so employed. Others came to the conclusion that it was best to leave the wounds open, others that healing by scabbing should be promoted, while the fear of the effect of air on wounds led to the introduction, in 1816, of subcutaneous surgery. About the middle of last century various antiseptic substances were a good deal employed, especially in France—balsams, chlorine, alcohol, chloride of zinc, iodine; and, very shortly before Lister's first publication, carbolic acid was advocated by Lemaire as an application to wounds. None of these antiseptic substances were, however, used on any definite scientific ground or with any definite method, and the result was, though a certain amount of improvement may have occurred, nothing like that which was brought about by Lister's systematic work was attained.

From the time Lister was a student, his mind had been occupied with the terrible fatal results which so constantly followed operations, however perfectly they were conducted, and he had definitely come to the conclusion that these troubles were associated with, and indeed the result of, the putrefactive changes which occurred in the blood and serum in the wound. He felt that if only these putrefactive changes could be avoided, the dangers which resulted would, in all probability, also disappear. So long as the view was held that these changes were due to the contact of the oxygen of the air with the discharges, the matter seemed hopeless, because it seemed impossible to perform an operation under conditions which would exclude the oxygen of the air. When, however, Pasteur in his work on "Spontaneous Generation," demonstrated that the oxygen of the air was quite unable to cause fermentative changes in organic fluids, and that these changes were due to living particles which fell into these fluids from the air, these particles belonging to the class of bacteria, the outlook became much more promising, for it was quite a different matter to have to do with particles which were simply floating in the air, and were often in small numbers and even entirely absent, than with gaseous substances which could penetrate everywhere.

Two courses were open in dealing with such particles, namely, to exclude them altogether, as in the experiments where the air was filtered through cotton-

wool, or else to destroy their vitality, as in the experiments where the air which was admitted to the organic fluid, was not filtered, but subjected to great heat. There is no doubt that Lister's first view was that the main organisms which produced this decomposition reached the wound from the air or from dust deposited on surrounding objects, although he very soon modified that view as a result of practical experience. Proceeding, however, on the view that the main contamination came from the air, the question which he put before himself was, what was the best way of dealing with the infective particles; should they be simply kept out by filtration of any air which came in contact with the wound, or should they be killed before they got into the wound, and if they were killed what would be the best way of doing it? To filter the air did not seem at all a practical plan, and therefore he at once took up the line of killing the organisms before they got into the wound, and the simplest way of doing so seemed to be by the use of chemical substances which had the power of destroying these minute forms of life, and were termed antiseptics. Curiously enough, the first chemical substance to which his attention was directed was carbolic acid, which still holds its place as one of the most potent and generally most applicable antiseptics.

His views and methods were constantly undergoing expansion and modification as the result of experience. Starting with the crude notion of bacteria in general, he very soon found that there must be a great variety of different species of bacteria, each having its own life-history and producing different noxious effects or none at all, and that the harm following the entrance of bacteria into wounds was, in the main, not due to those which produced the putrefactive fermentation. However much he modified his views and his methods of dealing with wounds, he held to the leading view that no bacteria should gain admission to wounds in a living state, although it was not long before he recognized that it was an ideal aim and that practically bacteria must gain entrance to wounds to a certain extent in spite of all precautions. This led him to postulate the second factor which had to do with the avoidance of sepsis, namely, the power which the tissues themselves possess in preventing the development of these micro-organisms, and that was the point on which he laid the very greatest stress, and in connection with that he struggled for years to reduce, and if possible, avoid altogether, irritation of the tissues in the wound, while at the same time, as far as possible, preventing the entrance of bacteria. Hence he was constantly changing his dressings and his methods, much to the perplexity of those who had not grasped the scientific ideas which were at the bottom of his researches.

These changes had a twofold object: one to obtain a more perfect sterilization of the air, and the various objects which came in contact with the wounds, and the other to avoid as far as possible the use of irritating substances, and more especially to prevent them coming in contact with the wound itself, and thus interfering with the natural action of the tissues in destroying any bacteria which might enter them in spite of the various precautions.

A study of his collected works which were published a year or two ago will show the remarkable perseverance with which he followed out these aims, and as examples of scientific writing, they are probably unsurpassed. He possessed to a high degree the quality of genius, in not overlooking what to the ordinary mind would appear minor circumstances. If an experiment did not turn out as he expected, he proceeded at once to ascertain the cause, and he did not throw it aside as simply an accident. In this way he was led to a great variety of information which the ordinary observer would have missed altogether.

But Lister as a surgeon did not direct his attentions solely to the treatment of wounds and the avoidance of septic troubles in connection with them. As soon as he found that he could reckon with reasonable certainty on the avoidance of these troubles, he proceeded to consider in what way he could improve the existing methods of treatment, and naturally the immunity from septic diseases opened up a greatly increased range of operative work. Hence very shortly after the successful application of his theories to practice, we find him suggesting operations and procedures as regards the treatment of diseases which had not previously been attempted, and were looked on by the older surgeons as almost criminal. Such operations, for example, as osteotomy for deformities, the treatment of recent fractures, such as fracture of the patella, by operation, extensive operations for the removal of cancerous glands in connection with cancer of the breast, the introduction of suprapubic colotomy, and a great many other procedures too numerous to mention.

Another point which should not be forgotten in connection with Lister is that it was his work which gave the main impulse to the development of the great science of bacteriology, a science which bids fair to occupy the most prominent place in medical work. It is true that he did not discover bacteria, nor did he take an active part in the bacteriological advances, but nevertheless he, along with Pasteur and Koch, may be looked on as a founder of the science. Until Pasteur's time the existence of bacteria and their life-history had been looked on as only an interesting but not very important study, and practically the only question asked with regard to them was whether they could arise spontaneously in organic fluids, or whether, like other living things, they must have had a progenitor. In other words, the battle raged for many years on the question of Spontaneous Generation. Pasteur was the observer who finally settled this question absolutely definitely, and showed that there was no such thing as spontaneous generation of living organisms, and that all organisms were derived from pre-existing

* Republished from *Nature*.

ones, and he further showed that organisms were the causes of the ordinary fermentations, including the putrefactive fermentation.

Until, however, Lister seized on the facts demonstrated by Pasteur, and applied them to the treatment of wounds, practically no one had looked on these organisms as of any importance in disease. As soon as Lister showed that the exclusion of these organisms from wounds meant the disappearance of a variety of diseases to which man had been previously subject, the study of these organisms naturally advanced with great rapidity. Lister, for some years, did work in that direction himself, but comparatively little progress was made until it was taken up by Pasteur, who, with his wonderful insight, drew deductions from his observations of far-reaching value. But the great progress dates from the time when Koch appeared in the field, and demonstrated definitely the relation of these organisms to disease, and showed how they could be detected and how they could be stained and cultivated. Since that time the science has gone ahead at a very rapid pace; but without Pasteur, Lister, and Koch, and more especially without the practical demonstration of the great importance of these organisms by Lister, it is impossible to say whether this science would have been in existence at all at the present moment.

I need not say anything about Lord Lister as a man. That he was conscientious to a degree, and considered any matters brought to his notice without any personal bias, is well known to all those who had dealings with him. That he never believed ill of anyone I can testify from long association with him; that those who opposed him were mistaken in their views was only a natural conclusion from the belief that he had in his own, but that any other motive influenced them in opposing him did not enter into his calculations. Above all, he was full of sympathy for suffering humanity. He spent an enormous amount of time in his hospital work, not only in making his observations and in watching the progress of the wounds under different methods of treatment, but also in relieving the suffering of the patients. He was often remonstrated with by the committees of the hospital to which he was attached for keeping patients in the hospital for a very long time, but he looked on the hospital as an institution for curing the patients, and would not let anyone leave so long as he was likely to obtain further benefit from remaining in it. When he came to London, there were several patients in his wards in Edinburgh, chiefly cases of spinal disease with abscess, who would naturally have been sent home after he left. Rather than allow them to run the risks consequent on that procedure, Lord Lister had several of them transported to London and placed in nursing homes at his own expense, and they were kept there for months until the disease was cured.

Poisonous Metals in Food Supplies

Their Sources and Action on the Economy

At no other period in the history of the world has the use of metals in the preparation, the conservation, and the distribution of food supplies been so extensive as at present. It may be said that the trail of the tin can marks the path of civilization. But most metal salts are very poisonous, which makes it of grave public import to ascertain the degree in which such salts may enter into foods by way of kitchen and factory utensils and more permanent containers, such as cans and boxes.

Dr. Carlo Formenti, of the Government Laboratory of Experimental Chemistry of Milan, has been conducting thoroughgoing researches into this matter and recently read a paper upon the subject before the Royal Society of Hygiene in Milan.

Dr. Formenti finds that poisonous metals are most usually found in acid foods, especially liquids, a fact especially noteworthy in America where lemonades and other sour drinks have attained such general use.

The contaminating metal most frequently found is lead, and this is of serious significance, since lead is known to physiologists as a cumulative poison, that is, very minute doses tend to remain in the tissues until a sufficient quantity of the poison has accumulated in the body to cause illness or death, as in the case of painter's paralysis.

The lead comes largely from the vessels employed in preparing the food, such as pots and pans, still worms, pipes, faucets, etc.

But in the case of beverages, in which it is especially prevalent, it may come from the constituents. Many of these soft drinks are made by adding orange or lemon juice or some other flavor to carbonated water containing a little tartaric acid. But lead is a frequent impurity both in crude tartaric acid and in carbon dioxide gas.

Dr. Formenti says: "I found from 1 to 20 milligrammes per liter of lead in such drinks and even in mere carbonated waters.

"The carbonic acid gas is made either from Carrara marble and sulphuric acid and contains all the impurities incidental to each (including arsenic, which is very commonly found in commercial sulphuric acid), or is obtained as a by-product in various manufactures."

The factories condense it to a liquid and ship it in metal cylinders to makers of aerated waters, champagne, beer, soda water, etc.

Formenti found both lead and copper frequently in large quantities in various distillates, aromatic waters, and brandies. Another source of lead was from the alloy of lead and tin used to plate sheet iron to form the ordinary "tin" can or box.

We read: The International Congress of Applied Chemistry held in London in 1909 laid down two laws concerning tin plate:

1. Tin cans must contain not more than 0.5 per cent of lead, nor more than 1.1 per cent of arsenic in their coating.

2. Pans, etc., for daily use require more lead by reason of the process of manufacture, but the amount should not exceed 5 per cent.

The lead found in tartaric acid, milk, sugar, citric acid, and such simple drugs may come from the pans in which crystallization or concentration is carried on, or from the enamel of enameled iron vessels.

Ices often contain small particles of lead, tin, and copper which have been rubbed off the walls of the freezer by the stirring apparatus.

Tin is frequently found in the contents of cans containing acids, and it should be noted that this occurs most frequently when the surface is incompletely coated, in which case the two metals and the acid fluid form an electric circuit.

Iron, too, is frequently present in canned goods, but is non-injurious or even beneficial, though it imparts a disagreeable styptic taste.

Zinc is little used and is not very poisonous, but care should be taken with regard to nickel-plated vessels; no acid food should be cooked in them, and no food whatever should be allowed to stand in them.

Dr. Formenti especially recommends aluminium utensils, since this metal apart from its valuable physical and chemical properties is practically non-corrosive, and entirely harmless besides, at least in such minute traces as may appear.

Silver and gold are practically out of the question in this connection, though it should be observed that certain silver salts are very toxic, including silver fluoride, which is sometimes used as a preservative.

Dr. Formenti's conclusions in regard to copper in goods are particularly interesting. We read:

"The poisonous character of copper has long been recognized, and scrupulous cleanliness is requisite in the case of copper utensils, as otherwise the action of food-particles and moist air on the metal result in the formation of the deadly verdigris, which may produce serious disturbances of health or even death. This holds good in spite of the fact that certain modern physiologists maintain that copper in exceedingly minute doses may have a beneficial effect, analogous to that of iron, on the red blood corpuscles. It may in fact, be used as a substitute for iron.

"Copper finds its way into preserved foods in various ways. Sometimes it proceeds from copper vacuum pans used for concentration of liquids and not plated with tin as is advisable. It is often found in wines; sometimes because the leaves of the vine have been treated with a solution of copper to destroy *peronospora*, and sometimes because the wine has been stored in copper vats instead of in wood.

"Copper also occurs in tomatoes or on grain where the parent plant has been treated with copper sulphate to destroy insects.

"Meal is sometimes treated with copper sulphate to disguise its inferior quality by whitening its yellow color, and the same thing is true of olive oil, etc.

"But copper is especially prevalent in nearly all canned green vegetables (beans, peas, etc.) because of the deplorable custom of tinting them green with salts of copper. In some countries this coloration is permitted by law within certain limits, but in my opinion the practice *should be everywhere abolished and forbidden*. In 1909 and 1910 I made numerous tests of such products, and I seldom found less than 100 milligrammes per kilogramme in the liquid drained off from such vegetables, while in hundreds of cases the amount ran as high as from 112 to 117 milligrammes per kilogramme. I also discovered copper in many brandies to the extent of 30 to 90 milligrammes per liter.

"Manganese is pretty widespread in its occurrence in nature, in the form of oxides, carbonates, sulphates, etc. It is correspondingly found in many soils and various fertilizers. It is a constituent of the ashes of certain plants, proving that it is assimilable by plant life, and is present in the blood and other fluids of the body. It is discoverable in certain wines and drugs, but always in very minute quantities. It is sometimes used as an adulterant of drugs to conceal inferiority of quality."

Formenti also found quantities of manganese in certain vinegars and was much puzzled at first by this circumstance, for which there was no obvious reason. But a painstaking investigation revealed the fact that certain manufacturers were in the habit of buying large quantities of refuse and rotting fruit for making a cheap grade of vinegar. The taste and odor of the vinegar were strongly affected by the empyreumatic odors from the decayed organic matter. Hence large amounts of potassium permanganate were added to oxidize this. While such vinegar may have certain commercial uses and is naturally much cheaper, Formenti thinks its use should be forbidden for food, in view of its origin, though as to the manganese itself, hygienists are not yet agreed whether it is injurious to health.

Both zinc and lead pipes affect the water which passes through them while new. Both, however, form oxides after a short period of use which are insoluble in water and thus form a protection, since they coat the surface and prevent further chemical action. Iron pipes are now frequently coated with tar both inside and out by a special process, which protects them from rust.

The chemist included arsenic in his investigations, though strictly speaking it is not to be classed as a metal. It was found in wine, beer, tartaric, citric, and sulphuric acids, glycerine, and some animal charcoals.

It was especially present in wines where arsenical solutions had been used as insecticides upon the vines. In 1908 the French government passed a law definitely forbidding the use of such solutions, both because of the deleterious action upon the wine and because they were found injurious to the health of the laborers in the vineyards.

Cooling Deep Mine Shafts

It is most injurious to the health to work in an atmosphere at a high temperature, especially if it is surcharged with moisture. These are just the conditions which exist in deep mines, and accordingly in many instances the law prescribes a maximum temperature permissible for mining work. It is customary to speak of a "geo-thermic degree," meaning thereby the depth in meters or feet which corresponds to an increase of one degree. In case of the Centigrade scale, the length of this is about 100 feet. Near the surface the fluctuations of the external temperature affect the reading of the thermometer below the ground; after a certain distance is reached, however, the temperature is practically constant through the year, and then increases downward at the rate indicated above. Thus, at a depth of about 2,500 feet, the temperature exceeds 86 deg. Fahr., and below this work becomes well nigh impracticable, unless artificial means of cooling are resorted to.

Mr. Dietz, in an article published in the *Zeitschrift für die gesamte Kälte-Industrie*, shows that the old methods are hardly capable of further improvement, and that the only avenue of betterment is to refrigerate the air *in situ* at the bottom of the mine by means of readily transportable apparatus. He points out that it is out of the question to cool the ventilating air simply at the surface on its way down for the following reasons:

1. A considerable transfer of heat takes place from the sides of the shafts and galleries, and the cost of a lining of insulating material would be prohibitive.

2. The air on its way down is compressed by the superincumbent column of air, and this compression is accompanied by the production of heat, amounting to one deg. Cent. for 330 feet.

The author states furthermore that even the use of brine refrigerated at the top of the mine and dispatched to the bottom is impracticable for similar reasons as those given above with regard to the use of cool ventilating air.

The only solution of the problem, therefore, is to have an air-cooling machine at the bottom of the mine,

Regulation of Radiotelegraphy

Restraining Unwarranted Use of the Ether

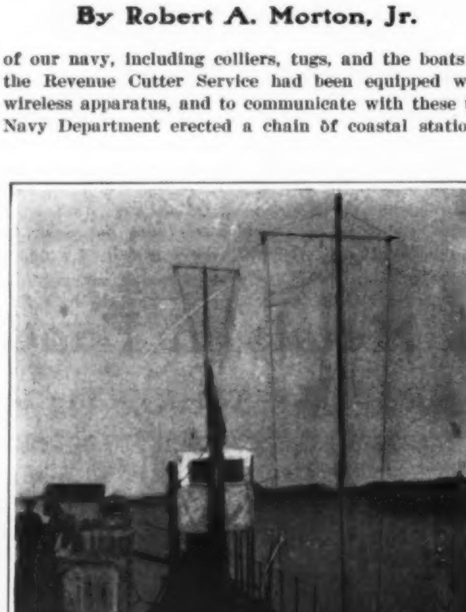
By Robert A. Morton, Jr.

Along with the scientific developments of the past decade that have brought about the conquest of the air have come legal problems of a nature somewhat new and perplexing. The popular use of the aeroplane, for example, will necessitate the birth of a new civil code to provide for the chance aerial wanderer who alights upon his neighbor's house at a cost of square feet of roofing and divers chimneys; and moreover the nations, recognizing the importance of the flying machine as an instrument of warfare, must come to exercise over aerial navigation an amount of supervision consistent with the requirements of national and public safety. Another aerial activity, radiotelegraphy, older than aviation by a few years, must likewise receive the attention of legislators. Indeed, the present world-wide use of the new telegraph has presented serious problems that seem to call for immediate solution.

From the year 1899, when Mr. Marconi with his experiments across the English Channel gave the first practical demonstration of radiotelegraphy, or "wireless" as a means of telegraphic communication, the new branch of science has progressed rapidly in all countries. Early dramatic incidents on the high seas stirred the public imagination, and awakened the world to the need of the prompt application of this latest and most wonderful life-saving device. Various inventors brought out improvements upon which new commercial systems were based, the principal steamship lines leased wireless instruments from these companies, and the governments equipped warships and built experimental stations for further study. The operation of the first stations proved beyond a doubt the extraordinary usefulness of the new telegraph on the sea, and at the same time called attention to certain inherent limitations in its efficient working.

To avoid a discussion of the so-called "wireless interference," let it suffice to state that this chief limitation arises from the impracticability, with present systems, of the *directive* and *selective* transmitting and receiving of electro-magnetic waves. Whereas the Morse telegraph connects two or more definite spots, the wireless station, on the contrary, throws off in all directions wave-messages that can be received at any and all stations within a circle, the diameter of which varies with the power of the apparatus. The results are loss of secrecy, for any person may "tap" the ether and relieve it of messages, official or commercial, public or private; also interference, accidental or intentional, for only one station can operate its highest efficiency at one time in any one vicinity. It appeared inevitable, despite prospects of future improvements, that the construction of thousands of wireless stations of the navies, of commercial companies, of experimenters, and of amateurs, would shortly produce an "etherial" chaos unless science should overcome the difficulties, or unless the indiscriminate building of stations should be prohibited, and the operation of all systems regulated by law.

Some degree of government regulation appealed especially to naval authorities. It increased immensely the possibilities in naval strategy of cruising, scouting, and fighting, and also in the handling of the fleets in time of peace. Within a few years practically every vessel of our navy, including colliers, tugs, and the boats of the Revenue Cutter Service had been equipped with wireless apparatus, and to communicate with these the Navy Department erected a chain of coastal stations,

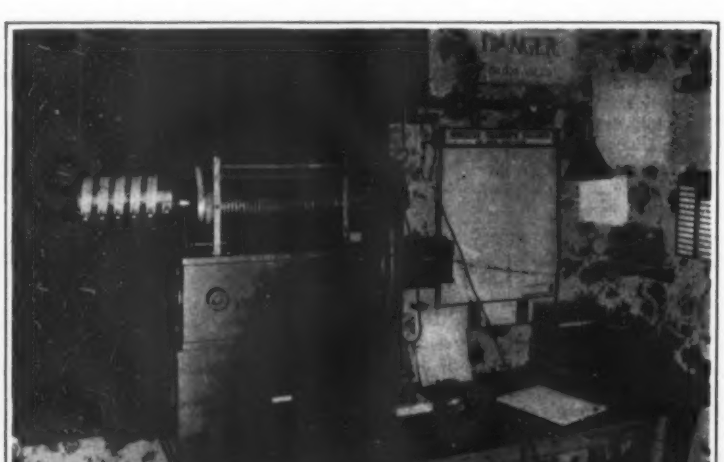


"Skip Jack," the First United States Submarine Successfully Equipped With Wireless Telegraph.

reaching from Maine to Alaska. These stations not only controlled the vessels of the navy, but performed important maritime services—the sending of official weather reports, storm warnings, news of derelicts, and other hydrographic information of value to our shipping. A very important part of their work became the control of the revenue cutters while on duty at sea. Reports of wrecks or distress signals were forwarded to these coastwise patrols, and the resulting saving of life and property has been one of the most creditable accomplishments of our naval wireless system. The revenue cutter "Gresham" has a record of over three score lives saved, and more than forty vessels towed from dangerous positions when out of control. One day in the winter of 1910 the "Gresham" saved twenty lives from five sinking schooners along the New England coast, a feat which would have been impossible without her wireless equipment. The naval system in these and in other ways served both naval and public interests. When, therefore, a host of rival commercial companies, more than one of doubtful parentage and mission, planted their stations at convenient stock-selling locations, often within a stone's throw of naval stations, and proceeded to congest the atmosphere with much miscellaneous and irrelevant conversation, government regulation became a popular theme in official circles. At this moment, when the press is full of "wireless finance" disclosures, and when some half dozen promoters who controlled practically all important American wireless interests are residing at Atlanta at the expense of the government, a discussion of the exploitation of the commercial field is unnecessary. With all the gross mismanagement, however, these concerns performed real service in numerous cases of emergency at sea. The spectacular rescues of one corporation, for example, have almost overshadowed the fact, more patent perhaps to the stockholders, that the company, capitalized at twenty million dollars has, since the government investigation, discovered a somewhat doubtful list of assets that total five hundred thousand. Hardly was it to be expected that such companies would consider technical efficiency of operation of primary importance. At one time five companies, American and foreign, operated stations within the limits of New York city, and of the five, four were so placed for no other purpose than catching investors. The efficiency of all five stations plus the naval station was fully fifty per cent less than any one of these stations working alone without interference. After a period of hostility, of intentional interference in cases, and of heated aerial discussion between operators, a mutual armistice was found necessary for self-preservation. At the present time each station attempts to some extent to await its turn to the ether, although other circumstances out of control of the individual operators have further reduced efficient working.

One interesting example of possible consequences of these methods of operation recently became public, or rather came to the attention of Congress.* Before a committee in the House of Representatives a certain commercial wireless company accused a rival concern of intentional and malicious interference with the operation of the plaintiff's New York station directly following the reception of a distress signal from a ship at sea, and during the period when the plaintiff was endeavoring to find the location of the vessel. Operators swore that the interference came from the station of the defendant, and consisted in holding down the key of the station and producing a continuous signal through which it was impossible to hear the ship's operator. So bad was the interference, stated the plaintiff, that no messages other than the SOS call could be received from the vessel, and it was necessary to communicate with the vessel by means of one other of the plaintiff's stations located at Atlantic City out of the range of the interference of the defendants. In reply,

* Hearing of Committee on Merchant Marine and Fisheries March 10th, 1910, p. 213.



A Two-kilowatt Amateur Station in Boston. This is Capable of Interrupting All Naval and Commercial Service Within a Radius of Fifty Miles.

Wireless Station That Can Be Carried in a Suit Case. The Outfit Has a Destructive Interference Radius of Five Miles.

the defendants produced sworn statements to the effect that their station had not been operated within several hours of the alleged interference because of a previous breakdown in the operating department. The representative of the defendants explained to the committee that the object of the accusation was to disguise the poor and inefficient service of the plaintiffs on the occasion referred to for the benefit of the inquiring stockholders. Similar cases of the same general nature are familiar to those interested, but none have reached the press for commercial reasons.

Another result of the government's *laissez-faire* policy is the amateur wireless operator, an individual that made his appearance when the first naval stations were built. At the present date it is said to number approximately 200,000. For the most part he is a school boy eager to explore the latest scientific mystery, to make his instruments or buy them from a dozen firms that make it their business to supply him, to memorize the wireless codes, from a local wireless club and system, and, last but not least, to outdo the regular stations in long distance work; all of which would be satisfactory were it not for two facts: the constitution of the ether, and the importance of the naval and commercial systems in safeguarding life and property on the sea. Unfortunately the amateur thrives along the coast and near the regular stations, and here he holds a strategic position, for he can prevent at will the operation of any other station in his neighborhood or within a distance of perhaps fifty miles. In some instances his interference has been malicious, as naval records show; in most cases it has been merely incidental to his wireless intercourse with his friends. Nevertheless, he has interfered with distress signals, and official dispatches, and has sent at least one fake dispatch—that in 1910 when a revenue cutter went to sea in a storm to look for a shipwreck that had its origin at an amateur wireless station. Yet the public, uninformed of the facts, have smiled indulgently. The humor of the situation has not been so apparent to wireless operators and steamship officers responsible for the safety of human freight. It is now better understood that so dangerous a toy cannot be tolerated in localities where either its use or abuse may mean disaster. Individuals who wish to experiment with dynamite are required to retire to a safe locality where their research will not interfere with the lives of others. There is this difference between the dynamite, and the interfering amateur station—the last is capable of infinitely more damage.

Experimental stations conducted by responsible persons naturally fall in a different class from the amateur. Such stations are necessary and can be conducted without increasing interference difficulties. A private school at Newport, R. I., for example, has a powerful experimental station in charge of a government licensed operator, the first station of its kind to be so managed. The vital seriousness of the presence of the amateur lies partly in the fact that, however the naval and commercial interests may improve operating methods, the amateur operator having no co-operative responsibility, cannot be included in the improved system. He must always be a disturbing element however innocent his intentions.

A still further stimulus to the desire for government regulation outside of purely domestic arguments arrived with the events of the Russo-Japanese war. Briefly the proposition may be stated thus: radiotelegraphy is of incalculable importance in time of war, both for belligerents and neutrals. Therefore, each government must for its self-defense control all public and private establishments within its territory.

Whatever doubt existed as to the effectiveness of radiotelegraphy in actual warfare was speedily dispelled by the story of the struggle in the Far East. Because of the wireless information sent by the Japanese scout cruisers Admiral Togo was enabled to locate the Russian fleet, and to devise an advance plan of attack. Throughout the long siege of Port Arthur two wireless stations, one within the fortress, the other within the grounds of the Russian consulate at Chefu offered the only means of outside communication, and it is said that their operation enabled the Russians to hold out weeks longer—at a cost of thousands of Japanese lives. The station at Chefu was worked continuously despite the entirely valid protest of Japan that China permitted its operation in violation of her neutrality obligations. Besides the stations on the warships of both fleets that were all of invaluable service, two other stations operated by the London *Times*, one in Wei-hai-wei, British territory, the other on board the chartered steamer "Haimum," took part in the campaign. These last stations secured the only available news of several naval actions. It is an interesting fact that the operators, though ignorant of the secret codes of the rival fleets, found it possible, through the varying strength of the signals, to estimate the approximate distances of the warships.

So exercised was Russia over this last affair that in 1904 the Russian ambassador communicated with Secretary Hay by circular letter as follows:

"In case neutral vessels, having on board correspondents who may communicate war news to the enemy by means of improved apparatus not yet provided for by existing conventions, should be arrested off the coast of Kwantung or within the zone of operations of the Russian fleet, such correspondents shall be regarded as spies and the vessels provided with wireless telegraph apparatus shall be seized as lawful prize." Later Germany declared that "a belligerent has the right to prohibit within the zone of hostilities, to be defined by him and publicly announced, the dissemination of information as to the whereabouts and movements of his war and merchant vessels and other warlike measures by means of wireless telegraphy on board neutral vessels."

Opening as it did intricate questions of international law, the war adaptation of radiotelegraphy became the principal argument for government control. The first attempt to take the growing science out of the field of private competition came in 1906, in the shape of the Berlin International Wireless Convention, which was signed by the representative of the United States, but which failed to pass the senate. This remarkable document was drawn up by the representatives of twenty-eight nations, and called for an absolute federal control of all wireless interests, subject, of course, to ratification by each nation. In addition to placing wireless telegraphy in government control, it prescribed routine operating methods, fixed charges for messages, and settled the technical problems—all with an amazing confidence in the eternal fixity of economic conditions and of the science itself European nations, inclined to federalize every interest, adopted this convention at a time when the natural development of the science should have been aided rather than restricted. As a result American invention has placed the science considerably in the lead in this country. Since the Berlin convention several bills for the regulation of wireless telegraphy have found their way into congress, remained for a time mute witnesses of the almost laughable technical ignorance of their sponsors, and perished in conference committee. One inadequate bill finally passed, providing that steamships carrying more than fifty passengers and traveling more than 200 miles from port to port should have wireless apparatus. It would be interesting to discover how the legislators arrived at the conclusion that fifty lives are worth more than forty-nine, or that ships never sink until at least one-hundred miles from port. In view of the fact that commercial wireless equipment costs each ship approximately thirty-dollars per month (one-third of the salary of one officer) it is easy to understand the desire of the committee to refrain from imposing ruinous financial burdens on any but the largest concerns. The following newspaper clipping is an eloquent witness to the wisdom of the men that sometimes make laws:

Edinburgh, January 8th.—Grave fears were expressed in shipping circles to-day for the Furness Line steamship "Amana," which sailed from Leith for Philadelphia on December 31st, and has not since been heard from. *The "Amana" carried a crew of thirty men.*

At the present moment Congress is considering another legislative measure of which we shall have more to say.

In the foregoing paragraphs the writer has attempted to outline the history of the practical application of radiotelegraphy, and of the consequences, both good and bad, of its unrestricted development. To-day it is clearly evident that however the past may have benefited by a *laissez-faire* policy, to-day some kind of responsible regulation is essential, and this not primarily for official interest in warfare, but as well for common sense domestic reasons. It is true that scientific advance has brought certain improved methods of operation. On the other hand these advantages have been more than offset by additional interference, due to the rapid increase in the number of stations, and to the increased power and range of the instruments. The use of wireless by the army, the recent successful adaptations to aeroplanes, balloons, and submarines indicate conclusively that the new telegraph will direct the next international struggle—that the "Message to Garcia" of the future will go by wireless. In an article on the Amateur Wireless Operator* in 1910 the writer stated that: "Because of its nature, the ether as a medium of domestic and international communication, will require safeguards in the form of wise restrictions and regulations, much as a city thoroughfare involving public safety and convenience demands efficient organization for the public good." This principle may be restated with emphasis to-day. The question remaining, and on this point there is a considerable difference of opinion, concerns the suitable nature and extent of national control.

Now, the policy of the government toward radiotelegraphy is limited to one of three alternatives:

1. Natural competitive growth without federal interference.
2. Government ownership and monopoly.
3. Government regulation and supervision.

The first proposition has the support of the commercial interests that must be effected by technical legislation requiring changes in wireless equipment, for a satisfactory system cannot be devised without very general changes in locations of stations and forms of apparatus at considerable expense. For reasons, however, already discussed, certain technical reforms must be instituted. The second proposition, in the opinion of the writer, offers the only satisfactory and permanent solution of the whole question of radiotelegraphy, for it should now be obvious that this activity has all the ear marks of a natural monopoly, and a natural government monopoly, and must finally become such. At the present time government ownership of public utilities is not a popular subject. The present method of attack therefore lies in the last alternative—government regulation and supervision.

All things considered, the legislation required falls under two heads: general legislation providing for emergency government control, and with penalties for willful abuses on the part of persons or corporations; and finally, technical legislation through the creation of a scientific wireless commission composed of naval, commercial and research experts who will consider and formulate suitable technical regulations for the operation of all domestic systems.

In a bill "To Regulate Radio-Communication" now before the Senate, the matter of general legislation is met fairly satisfactorily. It provides that all American stations, private and commercial, be licensed and placed in charge of licensed operators; penalties are prescribed for interference with distress signals, or with naval or military dispatches, and for the sending of fraudulent messages. Failure to comply with these requirements would mean forfeiture of apparatus, and in some instances fines and imprisonment. The needs of general supervision are fairly well met, but the arbitrary and official tone and wording of the act is highly objectionable. Furthermore the act destroys its usefulness by announcing a set of technical regulations for the operation of all stations. These rules require certain classes of stations to use certain wave lengths, and also waves of a certain technical form, difficult enough to obtain even in the laboratory. Ship stations must cut down power when within certain distances of *naval and military stations*, and commercial stations can operate only during the second half of every hour, and here only on condition that *naval or military stations* have no "important" business to transact. And these measures which would require sweeping changes in the equipment of all systems have been fathered by Senator Jonathan Bourne, expert in popular government, who thus confidently settles technical questions that have puzzled wireless specialists for years.

Four principal objections operate against this bill:

1. The wording and tone of the general provisions leave no room for doubt that the bill was designed by naval officers to subordinate commercial and private interests to naval and military interests.

2. The power given to the Secretary of Commerce and Labor to grant or withhold licenses at his discretion is excessive, and might lead to gross abuses. To suppose that one person in a short term of office could gain a comprehensive knowledge of so large a subject—one which he must handle as a dictator—is absurd. The plan is impracticable and impossible.

3. The proposed technical regulations are arbitrary, unproved, and purely experimental. Their adoption would lead to endless confusion and a tangle that would take more than one bill to rectify.

4. The proposed regulations would force immediate expensive changes in wireless telegraph apparatus, and would probably bankrupt all but one or two commercial companies whose foreign credit might save them. The act is practically confiscatory.

Little danger is there that this act will become a law. It is valuable, however, as an illustration of the extremes to which hasty ill-considered legislation can go when pushed by a single interest. Radiotelegraphy is in its infancy and the facts must be met in a broad non-partisan spirit. A representative commission in conference can settle these questions with minimum interference to legitimate interests, and at the same time with maximum benefits to all concerned; a result that will never be attained by the methods proposed by Mr. Bourne, and the department of the navy.

* *Outlook*, January 15th, 1910.

Portuguese Radium Mines.—Since 1908 an important deposit of uranium and radium minerals has been worked in Northern Portugal, between Guarda and Sabugal, in the Province of Beira. According to Mr. Segaud, the formation consists of a folded granite and Cambrian scists. A French society is exploiting certain minerals composed of a pegmatite containing fissures lined with cuanite (uranium phosphate), which, under concentration, gives a material holding as much as 2 per cent of uranium with a corresponding proportion of radium (that is to say, 1 centigramme of radium bromide per 30 kilogrammes of uranium oxide). There are 600 workmen employed. The mineral is worked up at Baracao for uranium oxide and radium-bearing radium sulphate. This latter is further treated at the Nogent Works in Paris, and the product is on the market in competition with the famous Joachimsthal material.—*La Nature.*

The Chemistry of Raw Sugar Production—I.*

By Charles A. Browne

Few commodities of commerce have acquired so wide and general an interest as sugar, and this interest we find exemplified in many ways. It is shown best of all perhaps in the large number of books and publications which have been written upon sugar. These books, a collection of which in the Library of Congress, in Washington, has been classified together in one catalogue, constitute in themselves a large library; there are books upon the history of sugar, upon the economics of sugar production, upon the agriculture of sugar-producing plants, upon the manufacture, technology and refining of sugar, upon the chemistry and analysis of sugar, upon the nutritive value of sugar, upon the tariff laws and bounties regulating the importation and exportation of sugar and so on and so forth. The importance of sugar in the commercial affairs of the world is so great that some economists have used the per capita consumption of sugar as a means of gaging the wealth and prosperity of a nation. It may be interesting to note in passing that the statistics of 1910 show the following consumption of sugar per capita for several different countries during the past year:

	Pounds		Pounds
England	86.30	Norway	41.78
United States	81.60	France	37.80
Denmark	77.75	Belgium	32.26
Switzerland	64.10	Austria-Hungary	25.14
Sweden	53.90	Russia	22.82
Holland	43.53	Spain	14.20
Germany	43.45		

The phase of the subject which we shall consider here is the part which chemistry and chemists play in the production of raw sugar. Sugar, i.e., sucrose, although composed of the common elements, C H and O—the two latter in proportion to form water— has not been made synthetically up to the present time. I mention this, for we read occasionally in the Sunday newspapers of sensational experiments where steam is injected into an electric furnace containing charcoal at one end and a continuous stream of the purest white sugar flows out at the other.

This imaginary process of making synthetic sugar is mentioned simply as an example of the countless number of fakes which are continually springing up in connection with the sugar industry; there are fake powders which applied to the soil will increase the yield of sugar cane or sugar beets; there are fake chemicals for clarifying and fake processes of boiling and crystallizing. So many people have been deceived by putting money into fictitious schemes, that sugar planters and manufacturers have become in some countries ultra-conservative; they refuse to adopt a really good invention when it does come along. It is one of the chief qualifications of the chemist who takes up any branch of chemical technology as a profession to be able to detect quickly the false and good features of the numerous new processes which are brought to his notice; he will increase his usefulness and earning capacity in this way many times over.

Sugar may, at some time, be manufactured synthetically just as indigo is now made; and when that day arrives it may also happen that synthetic sugar may displace the agricultural produce just as synthetic indigo is displacing the product of the indigo plant. But until the day of synthetic sugar does arrive we must be dependent for our supplies of raw sugar upon some one of the sugar-producing plants among which may be mentioned the sugar cane, the sugar beet, the maple tree, the palm tree and various plants of lesser importance as the sorghum and maize.

The oldest and best known sugar-producing plant is the sugar cane. This plant grows only in tropical and semi-tropical countries; it resembles in many ways the Indian corn, producing a jointed stalk varying from six to ten feet or even more in length.

In spite of the long years of its history the sugar cane is probably but little richer in sugar than it was when the soldiers of Alexander first tasted its juice. There is an important reason for this: the sugar cane is propagated almost entirely by planting the stalks, the buds or eyes germinating and producing a new cane resembling the old stalk. It is practically impossible to improve a cultivated plant without the agency of seed production; there must be cross-fertilization and some process of controlled selection. The sugar cane produces seed in a feathery plume at the end of the stalk, but the seed had been regarded as sterile until about thirty years ago, when it was found that under favorable conditions some of the seeds could be made to germinate; thousands of new canes have resulted from this discovery and these so-called seedling canes are displacing many of the old-established varieties. In the nurseries of tropical countries, where new varieties of sugar cane are bred, the problem of selection devolves almost entirely upon the chemist, who determines the percentage of sugar in the different canes, the purity of the juices and other factors which have to be considered.

The sugar cane, when the crop is ready, is harvested by cutting off the stalk as close to the ground as possible, trimming off the green tops and stripping off the leaves. These and the other agricultural operations of planting, fertilizing and cultivating require a large amount of labor, the expense for which makes up about three-fourths of the cost of the raw sugar, the remaining one-fourth being due to the expense of manufacture.

The composition of the stalks and the expressed juice of the sugar cane vary considerably. The general range of the different constituents as compiled from analyses made in different countries is given in the following table:

	Whole Cane, Per Cent.	Cane Juice, Per Cent.
Water	67 –75	80 –86
Dry substance	33 –25	20 –14
Fiber (cellulose, etc.)	10 –15	
Sucrose	11 –16	12 –18
Invert sugar	0.5– 1.5	0.5– 2.0
Ash	0.5– 1.0	0.4– 0.8
Nitrogenous substances	0.4– 0.6	0.1– 0.4
Gums, acids, etc	0.2– 0.5	0.3– 0.6
Wax and fat	0.4	0.2

Individual cases may show variations above or below these figures.

The sugar cane after it is hauled to the factory is first passed through mills to remove the juice. The cane mills are of all kinds and types, and range from the crude ox-driven mills employed in the Philippines and other primitive countries, to the high power, steam-driven hydraulic nine and twelve roller mills employed in Cuba, Java, Hawaii, Porto Rico, Louisiana, and other countries where the most modern machinery is used. In the best equipped factories the cane is delivered by an endless carrier to huge corrugated crushers, which reduce the stalks to a thick blanket of pulpy fiber, removing at the same time some 50 per cent to 60 per cent of the juice. The crushed stalks pass next through a mill of three rollers, where still more of the juice is removed, and then through a second, third and sometimes a fourth set of such rollers, the hydraulic pressure upon the rollers being increased at each mill in order to remove more and more of the juice. It is also customary to wet the pulp with a thin spray of water between the sets of rollers, the water thus soaked up facilitating the removal of the residual sugar by the succeeding rollers. This process of wetting, of maceration, as it is called, is highly important, but requires to be carefully controlled; the water added must of course be afterward evaporated and the question which the chemist must decide is when the cost of evaporation begins to exceed the value of the extra sugar recovered. Large numbers of treatises have been written upon maceration and scarcely any two authorities are found to agree upon the details of manipulation. The quantity of water used for wetting the fiber is usually about 15 per cent per 100 parts of normal undiluted juice, although 25 per cent and more is sometimes used. With 15 per cent maceration about 90 per cent of the sugar in the cane is extracted in the juice; with 25 per cent maceration over 95 per cent of the sugar may be extracted. The residue of cane fiber as it leaves the last mill contains about 45 to 50 per cent moisture and from 3 to 5 per cent sugar, i.e., from 5 per cent to 10 per cent of the original sugar in the cane. This residue of fiber is called "bagasse" and is burned under the boilers; it constitutes the chief and in some countries the only supply of fuel for operating the sugar factory.

The polarization and purity of the raw juice are the first important factors to be determined in the chemical control of a cane sugar factory. The polarization of the juice will give the approximate sugar content; the dissolved solids in the juice are estimated by means of a floating hydrometer called a Brix spindle. The polarization of the juice multiplied by 100 and divided by the reading of the Brix spindle gives the purity of the juice. Good cane juices run over 90 per cent purity, juices running from 85 to 90 per cent purity are fair, and from 80 to 85 per cent medium. Juices with a purity below 80 per cent are poor and very unsatisfactory to work.

The second step in the manufacture of cane sugar is the clarification or purification of the raw juice. The best clarifying agent and the one that has been used from time immemorial is lime. Nothing better has ever been found, although hundreds of patents have been taken out for substitutes.

Many methods of using lime are practiced and a few of these will be described. Cane juice as it comes from the mill is slightly acid. One method of clarification is to neutralize this free acid of the juice by adding lime to slight alkalinity, and then to heat to boiling. The lime combines with the organic acids and phosphoric acid of the juice and the heat coagulates the albumenoid substances; a thick scum of impurities rises to the surface, this is skimmed off and the hot juice run into settling tanks when the suspended impurities settle out. More often the juice is passed through filter presses and the impurities removed in this way. The residue of impurities called "filter press cake" contains the phosphates and nitrogenous matters of the juice and is returned to the cane fields as a fertilizer.

In many factories the cane juice is sulphured before liming, gaseous SO_2, produced by burning sulphur, is led into the juice to a certain point of acidity; the free acid is then neutralized with lime and the juice heated as first described. The SO_2 has a favorable bleaching effect upon the juice and the mechanical separation of the impurities is greatly facilitated by its action. Objections against its employment are the increase in scale (mostly $CaSO_4$) which forms upon the tubes of the evaporators and the contamination of the molasses with sulphites, the latter being forbidden in food products by the laws of some of the states. In some factories phosphoric acid is used with the lime; this gives a beautiful clarification but does not give the bright effect which bleaching with SO_2 brings about.

In some countries, notably in Java, lime is added to the juice to strong alkalinity and the excess of lime then removed with CO_2. This process of clarification called carbonation is the only one used in beet sugar manufacture. It works well with cane juices when but little invert sugar is present. If the latter occurs in large amounts the lime forms dark-colored soluble compounds which not only give a dark-colored sugar but interfere seriously with the work of evaporation and crystallization. Such juices are said to be lime-burnt. The tendency at present in cane sugar manufacture is against carbonatation and all other methods of strongly alkaline clarification.

The third process in the manufacture of cane sugar is that of *evaporation*. In primitive countries and out-of-the-way plantations evaporation is carried out over the direct fire in open pans or kettles. The juice is either boiled down in one single kettle or passed through a train of pans; when crystallization of the sugar has begun great care must be exercised that the mass be kept in constant motion; otherwise there will be burning and caramelization next to the surface of the evaporator. Such caramelization is in fact unavoidable, and all open kettle sugars are characterized by a dark color and by an agreeable aromatic taste which is preferred by many to that of the pure refined sugars. In some countries the cane juice after evaporating to a thick pasty mass is allowed to cool and solidify, just as molasses candy hardens after cooling. This solidified mass is called *concrete sugar* and is ground up in mills and marketed as a coarse lumpy sugar of very uneven composition. This concrete sugar contains of course all the molasses with the soluble impurities of the juice. Such sugar constitutes at present almost the sole output of the Phillippine Islands. It is shipped to this country in mats weighing about 50 pounds and comes in three grades which contain all the way from 80 per cent to about 90 per cent pure sucrose.

In other primitive countries, expecially in parts of South America, the juice is not evaporated to concrete but only to the consistency of a thick mush; this mush is run into hogsheads having a fine perforated bottom through which the molasses or mother liquor surrounding the crystals of sugar percolates. When as much as possible of the molasses has drained away the residue of sugar is removed and sold as *muscovado* sugar. This is purer than concrete sugar and polarizes sometimes as high as 92 per cent. It is usually quite moist and for this reason is very liable to deteriorate.

In the open kettle process of evaporation there is always considerable loss of sugar due to caramelization and inversion caused by the high temperature of heating which may be from 20 deg. to 30 deg. Fahr., above the boiling point of the water. To avoid these losses all modern sugar factories employ vacuum evaporators which allow evaporation to proceed at a temperature much below the boiling point of water and at the same time permit the utilization of waste steam from the exhaust of the engines and other points about the factory. Vacuum evaporators are manufactured in many different forms, and are arranged usually in a series of two, three or four sometimes even as high as five or six, the combination being called double, triple, quadruple, quintuple, or sextuple effects. The steam which is

* Lecture delivered to the third and fourth-year students in chemistry and chemical engineering of Columbia University, New York City, and orginally published in the *School of Mines Quarterly*.

evaporated from the juice in the first vessel goes to heat the coils of the second vessel, the steam from the second vessel goes to heat the coils of the third, the reduction in temperature of the steam for each vessel being of course counterbalanced by the greater vacuum and lower temperatures necessary for boiling. With a long series of vessels as in a quadruple or quintuple, or sextuple effect, the thin juice in the first body may be boiled under atmospheric pressure or even at a few pounds above this; this is necessary in order to get a high enough temperature to carry sufficient heat through to the last evaporator. The subject of multiple evaporation is a science in itself and exhaustive treatises have been written upon this one single phase of sugar manufacture.

After the clarified juice has been evaporated to a syrup we come to the fourth stage of the process of modern sugar making—the graining or crystallizing of the sugar. This is accomplished in a vacuum pan which is operated in much the same way as one of the vessels of an effect; in the case of the vacuum pan, and the same is true with many other effects, the process is assisted by connecting the outlet with a vertical condensing column 28 feet high. A stream of cold water flows through the column and this serves both by rapid condensation of the steam and by the barometric pull of its column of liquid to maintain a high degree of vacuum.

To operate the vacuum pan a charge of syrup is first drawn in; this syrup as it leaves the evaporators has a specific gravity of about 1.25, corresponding to about 50 per cent solids, and is boiled down in the vacuum pan to a specific gravity of 1.50 or about 90 per cent solids. The ebullition in the vacuum pan is violent and unless the sugar boiler is careful some of the syrup may be carried over with the vapor into the condenser; this is called *entrainment* and is a source of frequent losses in sugar manufacture. In all modern sugar factories the chemist makes constant examination of the condensation water, using the familiar α-naphthol test with H_2SO_4, this test being delicate enough to detect one part of sugar in many thousands of water.

The handling of the vacuum pan requires more skill than any other operation of the sugar house; care must be taken to avoid entrainment and to build up crystals of uniform grain or size. The usual practice is to boil down the first charge of syrup to what is called "string proof," i.e., to the point when a few drops of syrup withdrawn from the pan will draw out between the fingers in fine strings or threads. When this point is reached a large charge of fresh cold syrup is drawn into the pan, the sudden cooling of the supersaturated contents starts the formation of innumerable fine crystals. These first crystals constitute the foundation so to speak of all the sugar obtained in a given boiling or strike of the pan; the boiler aims to build up these crystals without forming new ones; he aims from now on to avoid supersaturation and to avoid sudden chilling through drawing in too much syrup at one time. He controls his process by drawing out samples every few minutes and examining these upon glass against a light; if he sees fine new crystals appearing among the old ones he reduces the vacuum a little, thus raising the temperature and dissolving this false grain as the fine crystals are called. By skillful manipulation, which only comes with long practice and experience, the sugar boiler is able to build up his crystals to any desired size; the usual practice is a crystal about the size of ordinary granulated sugar; in certain localities, however, a large crystal is favored, as for example, in Peru, where the sugar is boiled slowly and for a long time, thus building up a very large grain.

When the vacuum pan is filled with a thick magma of sugar crystals, of about the consistency of mortar, the steam is shut off, air is admitted, the bottom of the pan opened, and the entire contents dumped into a mixer, which keeps the mass in slow movement by means of revolving arms. This mixer is situated over a row of centrifugal machines; the mass of crystals called sometimes *masse cuite* from the French or *Füllmass* from the German is drawn off gradually in successive charges into the centrifugals. The inner walls of the latter are lined with fine brass meshing and as the drums are rotated the *masse cuite* is whirled against the meshing which retains the sugar but allows the molasses to pass through. After spinning for a few minutes until as much of the molasses is removed as possible, the revolving mass of sugar may be sprayed with a fine spray of water or a jet of steam in order to remove more of the film of molasses which remains adhering to the crystals; the amount of spraying depends upon the whiteness of sugar desired. In Louisiana a very pure, white sugar is made by spraying with several sprinklings of water; such sugar is over 99 per cent pure sucrose, the remainder being mostly moisture. In Cuba and Porto Rico they aim to make a 96 per cent sugar. In Hawaii and Java a sugar testing about 97 per cent is desired. Spraying will, of course, dissolve some of the sugar, so that the process is one which must be carefully controlled.

After the sugar is spun out, the centrifugals are stopped and the sugar emptied through the bottom of the drum into a conveyor by which it is carried to the bagging department where it is prepared for shipment. The raw sugar from the centrifugal contains considerable moisture and in some countries the sugar is dried in revolving drums before being bagged. This drying is advantageous for two reasons: (1) The excess moisture is removed, thus saving the transportation charges upon water, and (2) the sugar is sterilized and protected against the attacks of ferments and bacteria. The drying of raw sugar is not practiced in Cuba, Porto Rico or Louisiana, but is carried out in Java and the Hawaii Islands where the sugar has to be shipped for long distances to this city and other ports for refining. The storage of undried raw sugar for long periods of time is a risky operation, as many speculators in sugar have found to their cost.

The sugar which is made from the pure juice of the cane is called "first sugar" and the molasses drained from this sugar is called "first molasses." The latter still contains a large amount of sucrose and various processes are used to recover as much of this as will crystallize. The first molasses is sometimes boiled down again in the vacuum pan and a second crop of sugar crystals obtained; this is the second sugar and the molasses obtained from this the second molasses. The second molasses may be boiled even again and a third sugar obtained, the molasses from which is the third or final molasses. Of course, as the sugar is removed the impurities become more and more concentrated in the molasses, until finally a thick stringy mass is obtained which will no longer crystallize. Such a molasses may still contain, however, 30 per cent sucrose; there is also present about 30 per cent invert sugar, 8 to 10 per cent of ash, and 8 to 10 per cent of gums, organic acids, amido-compounds, etc. This residual molasses is unfit for human food, although attempts are made to bleach it, dilute it with glucose and make it otherwise presentable. The waste molasses is valuable, however, as a cattle food and is also used by distilleries for making alcohol.

The tendency of modern methods in cane sugar manufacture is against the repeated boiling of molasses; the aim is to get as much sugar as possible in one operation. Many processes have been devised to attain this end. One method is to take the molasses from the first strike of sugar, draw this into the vacuum pan with the syrup for the succeeding strike and boil the two down together. The *masse cuite* from this mixture is then run while still hot into large tanks, called crystallizers, where it is kept in slow motion by means of revolving arms; as the mass cools and thickens more molasses is drawn in to keep the proper degree of fluidity. When no more sugar will crystallize as determined by analysis of samples, the contents of the crystallizer are spun out in centrifugals and the molasses withdrawn from the factory. There are many modifications of this process, each sugar manufacturer having usually a pet scheme or method of his own.

With this very hasty description of the sugar cane industry we will pass to the great rival of the cane, the sugar beet. The history of the sugar beet industry extends back only about one hundred years, but though centuries younger than the cane industry the story of the development of beet sugar manufacture is in many respects more interesting to the chemist. The sugar beet may be called the foster child of chemistry; in its wild uncultivated form, even as we find it growing to-day, the primitive sugar beet is very deficient in sugar. The beet, however, belongs to a much younger family of plants than the cane; its habits are not so firmly fixed; it accommodates itself more easily to new conditions. The propagation of the beet by seeds, instead of by buds as with the cane, has rendered it easy to build up the sugar-producing capacity of the plant until it has reached and in some cases even passed beyond that of the cane.

I ought to mention here the important historical event which led to the founding of the beet sugar industry: it was the great continental blockade established by the fleets of England against the whole continent of Europe during the wars with Napoleon. The nations of Europe shut out from their supplies of cane sugar were driven to devise a substitute; in some countries, as in Bohemia, they made sugar from the maple, in other countries they crystallized dextrose from the juice of the grape, but these sources were inadequate. The final outcome of the matter was the birth of the beet sugar industry. It was one hundred years ago in 1810 that the first loaf of beet sugar was made and presented to Napoleon; and the centenary of this event has just been celebrated in France.

It is doubtful if the beet sugar industry could have made much progress, had an important piece of apparatus, the polariscope, not been invented about this time. The polariscope offered a quick and rapid method for determining the amount of sugar in beets. There was thus established a means of selecting beets for the production of seed—mother beets as they are called. A small boring is taken diagonally through the heart of the beet and the percentage of sugar determined in this by the polariscope. The beets of highest content are planted for seed; the same process is carried out with the second generation of beets grown from the seed of the first and so on generation after generation. In this way the original sugar content of the beet of only a few per cent has been raised to 14, 16 and even 18 per cent. The process of seed selection is still kept up and in the seed nurseries chemists are kept constantly employed polarizing mother beets for seed production. The work demands constant vigilance; a plant easy to improve will deteriorate even more easily; if the sugar beet were left to itself it would revert in a few generations to the old condition of low sugar content.

Extremely large beets are usually deficient in sugar and are not desirable; a medium sized beet is most preferred. Many beet growers place considerable stress upon the spiral twist which the root sometimes assumes; this factor, however, is probably of little significance.

Before taking up the details of manufacture we should look for a moment at the composition of the sugar beet and its juice. The average range in composition is given in the following table:

	Sugar Beet, Per Cent.	Sugar Beet Juice, Per Cent.
Water	75 —85	78 — 84
Dry substance	15 —25	16 — 22
Fiber (cellulose, etc.)	4 — 6	
Sucrose	12 —16	13 — 17
Invert sugar	0.0— 0.3	0.0— 0.3
Ash (salts)	0.8— 1.5	0.6— 1.0
Nitrogenous substances	1.5— 2.5	0.8— 1.5
Gums, acids, etc	0.4— 0.8	0.3— 0.6
Wax, fat, etc.	0.2	

It will be noted as compared with the cane there is much less fiber in the beet and more water; there is also more ash (or salts) and more nitrogenous matter, but much less invert sugar than in the cane. These differences in composition have an important bearing upon the differences in process of manufacture.

In the first beginnings of the beet sugar industry the beets were crushed and the juice pressed out in much the same manner as with the cane; this process, however, soon gave place to the process of diffusion. The beets, after they are dug and deprived of their green tops, are hauled to the factory; they are first washed to remove adhering dirt and then passed through revolving knives which reduce them to fine slicings.

The fine slicings are next carried by a conveyor to the diffusion battery, which consists of a series of tall boiler-shaped cylinders called cells. These cells are connected together by pipes, the outlet from the top of one cell passing downward into the bottom of the next and so on around. Each cell is filled with beet slicings through a manhole at the top and when full is tightly closed with a cover which is clamped into place. Twelve cells connected in series usually constitute a battery and when all are filled, warm water of about 80 deg. Cent., is passed through the system. The water circulating through each cell removes the sugar from the beet slicings and of course becomes richer and richer in sugar with each succeeding cell. Heaters are placed between the cells so that the circulating water is kept always at the right temperature. When the water has made a complete circuit through the twelve cells of the battery the slicings in the first cell are practically exhausted; this cell is then thrown out of circulation, emptied of exhausted chips, refilled with fresh slicings and reconnected with the system, while the second cell undergoes replenishing. The process is thus a continuous one; ten cells are always in circulation while one is always being emptied and one always being refilled. This goes on continually during the beet campaign, night and day, Sundays and holidays; interruption at the diffusion battery upsets the work of the whole factory.

The exhausted slicings from the diffusion cells are dried by the heat of the flue gases from the boilers and are then sold as a cattle food.

The diffusion juice as it leaves the last cell of the battery contains from 12 to 15 per cent sugar and is then ready for clarification. The juice is first treated with a considerable excess of lime; and the dissolved lime precipitated by leading in a stream of CO_2.

The burning of lime is an important operation in every beet sugar factory, the lime being used for saturating and making saccharate; and the kiln gases, which contain on the average of about 30 per cent CO_2 being pumped off for carbonating.

After the first treatment with lime and CO_2 the precipitated $CaCO_3$, and other impurities are filtered off in filter presses and the juice subjected to a second carbonatation at a higher temperature. Less lime is used in this second carbonatation, the final alkalinity being only a few hundreds of a per cent CaO.

The juice from the second carbonatation is again filtered, when it is evaporated, grained, and centrifugaled, these processes being carried out exactly as described for cane juice.

To be continued.

The Bernin[a] Ra[ilway]

From Valley Vineyar[ds to] Mou[ntain]

By Dr. Alfre[d] ...denv...

The Station at Grüm.

THE Bernina Railway connects with the Rhaetian line at St. Moritz and Pontresina and with the Valtellina Railway at Tirano. It not only establishes excellent communication between the Engadine and Italy, but is also the most important intermediary link for the traffic between Eastern Switzerland and Lombardy and Venice. All along the journey the traveler finds himself in the most exquisite scenery, displaying the various types of vegetation characteristic of the altitudes traversed, from the vineyards of the Valtellina to the barren stretches of snow and ice of the imposing Bernina range. The line owes its existence to the construction of the Brusio Central Station, which was financed by the Alioth Electricity Co. of Basle.

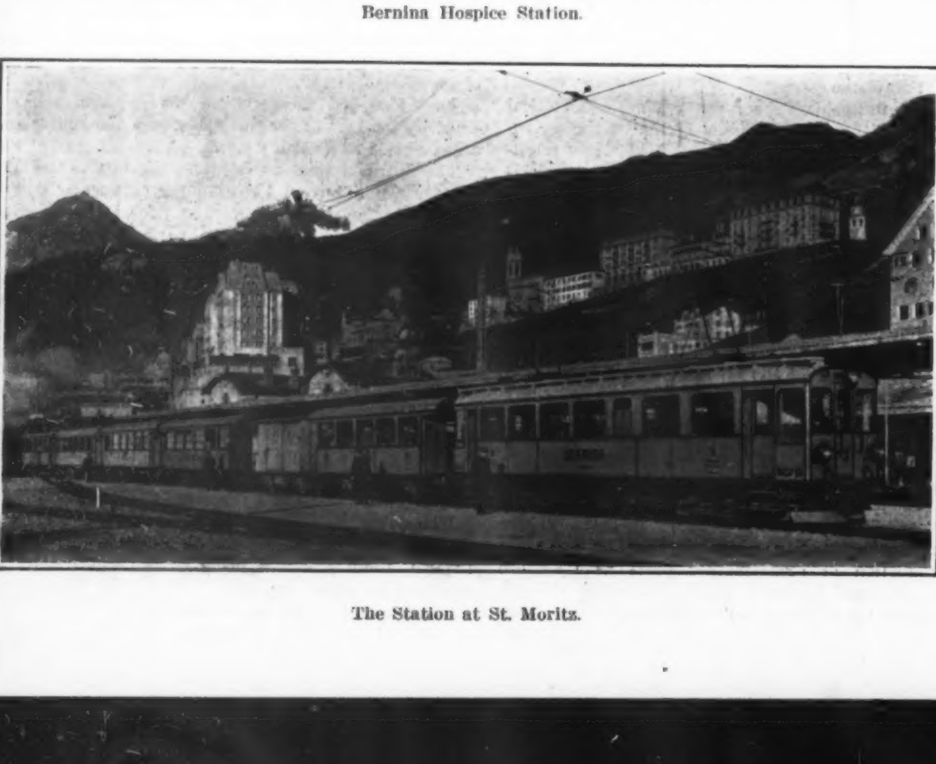
The railway is built on 1 meter (3.28 feet) gage and is of the adhesion type and covers a distance of 37.3 miles.

Starting from the world-renowned health resort of St. Moritz, at 5,833 feet above sea level, the Bernina Railway follows the Inn Ravine, and passing through a tunnel 2,297 feet in length, reaches Pontresina. From here it ascends along the valley on its western flank to the much-frequented Morteratsch glacier, after touching which point it turns toward Montebello and reaches the Bernina Road. It follows this as far as the lake situated near the Hospice, attaining its highest point at a level of 7,402 feet above the sea.

The downward course of the line is laid along the Val di Pila, passing in broad, serpentine loops in the immediate neighborhood of the Palü glacier, which crosses the Plateau of Cavaglia and, after making some further loops, reaches Poschiavo; from here it follows the main road as far as the lakes bearing this name, and after descending the steep valley reaches the terminal station of Tirano at 1,407 feet above sea level. The total difference in level on the north side from St. Moritz to the Bernina Hospice is 1,568 feet in 13.8 miles, and on the south side from Tirano to the Hospice no less than 5,994 feet in 20.7 miles. Thus, the total climb is greater than that of any Swiss Railway. The maximum gradient is 7 per cent, and the curve of smallest radius is 131.3 feet This latter, however, occurs only in a few exceptional places.

Bernina Hospice Station.

The electric power used for operating the railway is supplied by the Campo Cologno power-house of the Brusio Supply Company, which derives its water-power from the Lake of Poschiavo through a penstock 3.2 miles in length, leading to a reservoir connected through a pressure conduit about 0.62 mile in length, and 6 pipes under a head of 1,394 feet to the power-house. This latter contains 12 sets of 3-phase turbo-generators, each of 3,000 K. V. A. and rotating at 375 revolutions per minute and generating 3-phase current at 7,000 volts and 50 cycles. The generators are provided with 4 exciter sets. The major part of the energy generated at the power-house is stepped up to 50,000 volts for transmission and supply system of the Societa Lombarda. The Robbia power-house, near Poschiavo, which likewise belongs to the Brusio Supply Company, serves as a stand-by, and a small power-house of the same company, on the river Sajento, affords an additional reserve. The current used for operating the railway is direct current at 750 volts. The high-tension, 3-phase current generated at the power-house is converted into direct current at four stations distributed along the railway and feeding the trolley wire. The high-tension transmission line mounted on



The Station at St. Moritz.

Interior of the ... Station.

ernin Railway

Vineyard Mountain Glacier

r. Alfre denwitz

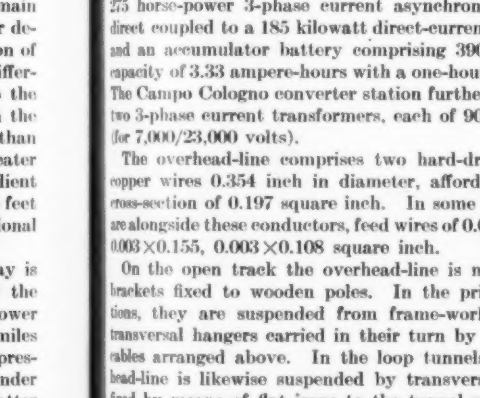
special poles mostly runs alongside the railway line, connecting the four converter stations with one another and communicating also with the Robbia power-house through a special conductor. It comprises three semi-hardened copper wires, each 0.236 inch in diameter, arranged in a triangle at a vertical distance of 31.5 inches. The insulators are tested to withstand 60,000 volts for one hour. Four sets of high-tension, horn-shaped lightning arresters and water rheostats as well as four cylindrical lightning arrester batteries afford protection against atmospheric discharges. On account of the enormous difference in level amounting to 5,905 feet, very considerable static charges occur. No ordinary difficulties of construction had to be overcome in erecting this line through the mountainous region into which it extends. In winter the snow in some places is heaped up as far as the lowermost wire; in spite of this the service of the railway has been maintained without any hitch throughout the cold season.

Three of the converter stations are identical in their general arrangement, being fed with a 3-phase current at 23,000 volts, which they reduce to 500 volts and convert into direct current of 800 volts. The fourth converter station, situated at Campo Cologno transforms only part of the incoming current from 7,000 down to 500 volts, while the remainder is raised for high-tension transmission from 7,000 to 23,000 volts. Each converter station contains two 3-phase current transformers, each of 260 K. V. A. (20,000/500 volts), for transforming the incoming current, two converter sets, each consisting of a 275 horse-power 3-phase current asynchronous motor, direct coupled to a 185 kilowatt direct-current generator and an accumulator battery comprising 390 cells of a capacity of 3.33 ampere-hours with a one-hour discharge. The Campo Cologno converter station further comprises two 3-phase current transformers, each of 900 K. V. A. (for 7,000/23,000 volts).

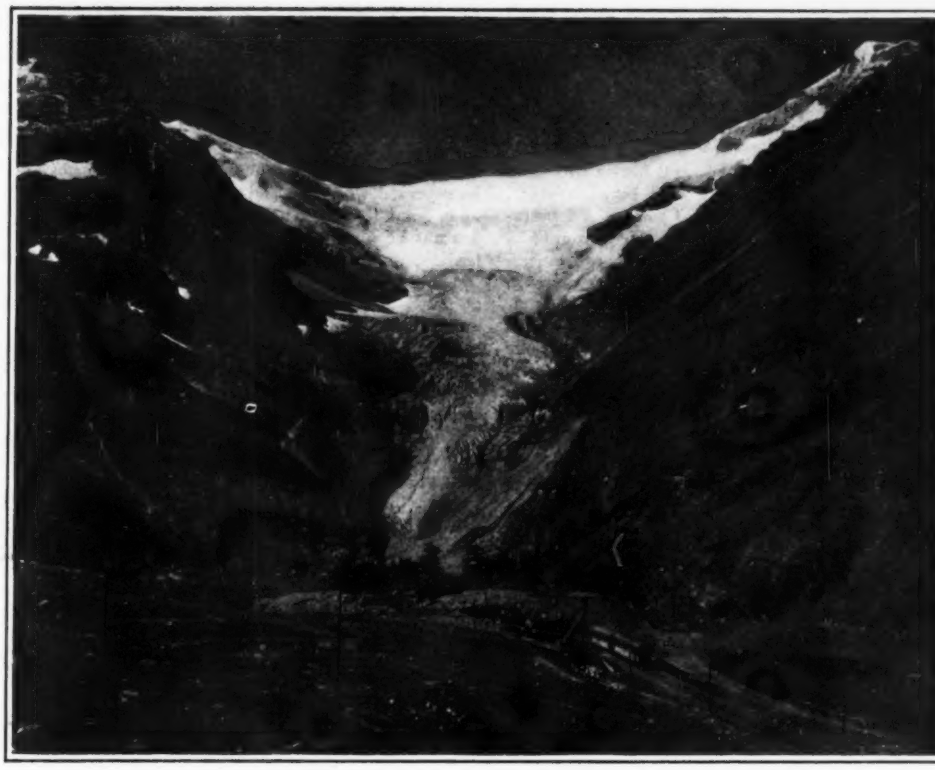
The overhead-line comprises two hard-drawn round copper wires 0.354 inch in diameter, affording a total cross-section of 0.197 square inch. In some parts there are alongside these conductors, feed wires of 0.003×0.186, 0.003×0.155, 0.003×0.108 square inch.

On the open track the overhead-line is mounted on brackets fixed to wooden poles. In the principal stations, they are suspended from frame-work poles by transversal hangers carried in their turn by supporting cables arranged above. In the loop tunnels the overhead-line is likewise suspended by transversal hangers fixed by means of flat irons to the tunnel vault. The feed-wires are fixed to bell-shaped porcelain insulators, the supports of which are cemented into the tunnel vault. In the Charnadura tunnel both the feeder and lighting conductors are fixed on a profile iron below the summit, while the transversal wire of the trolley-line is arranged on wooden girders. The overhead-line is subdivided into a certain number of sections by section-switches closed under normal conditions. Each section can be cut out without interfering with the operation of the remainder of the line.

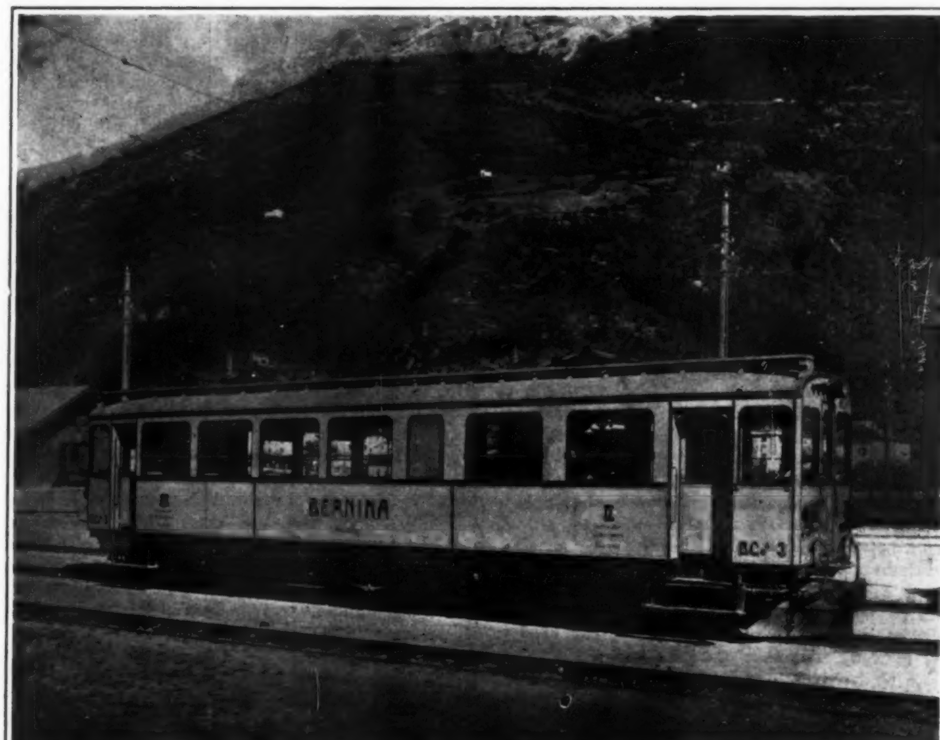
The rail-joints have been bridged by means of special copper fish-plates, insuring a better conduction, the rails serving as return line. There are also at each 328 feet distance transversal rail-connectors consisting of round copper wires 0.354 inch in diameter, which are screwed to the web of the rail.



erior of the Station.



Palü Glacier as Seen From the Grüm Alps.



The Passenger Motor Car.

Viaduct at Brusio.

The mechanical part of the rolling stock was supplied by the Schweizerische Industrie-Gesellschaft, at Neuhausen, and the electrical equipment, by the Alioth Electricity Company.

Each of the four-axle passenger motor cars comprises a car body with completely inclosed platforms, seating accommodation for 31 first-class and 12 second-class passengers. They are supported on 2 bogies with 6.56 feet wheel-base and 26.2 feet distance between pivots. The electrical equipment of each car comprises 4 series-current motors, each of a normal permanent output of 75 horse-power, 2 controllers, a set of regulating resistances, 2 current-collect-bows, a horn-shaped lightning arrester, a car fuse with magnetic spark-extinguisher, 2 maximum-current automatic switches, a full set of measuring instruments, a motor for the Hardy vacuum brake, 2 brake switches for the Hardy and rail brakes, 1 electro-magnetic rail-brake, lighting circuit and an electrical heating equipment.

The four motors of each motor car have to haul a train of 45 tons on a maximum gradient of 7 per cent, at a speed of 11.2 miles per hour, the speed on the level being 27.96 miles. Each bogey carries two motors, each of which has a normal permanent output of 75 horse-power, with 515 revolutions per minute and 750 volts. The wheel-axles are driven through a toothed-wheel gearing, at a ratio of 1:4.5. The motors are of the same type as those used on a number of other Swiss railways.

The controllers are designed for series and parallel connection as well as for electrical short-circuit breaking and comprise a main roll as well as switching and switch-out rolls. In order to avoid any false manipulation on the part of the personnel, the main and switching rolls are locked with one another, so that the latter can only be actuated when the main crank is at zero, while the main crank is blocked at zero, so long as the switch-lever has not been adjusted to one or the other direction of traveling. The third roll (viz., the switchout roll) which can only be operated with open controller and the switch adjusted to zero, allows any defective motor or set of motors to be cut out.

This controller which allows the train to be started on the maximum gradient and readily to pass from series to parallel connection with a current intensity of 200 amperes, has given excellent results on the Bernina railway.

The current is collected from the overhead-line through two elastic bows which automatically turn to the direction of traveling. The current of both bows first traverses a lightning arrester and a main fuse with substantial magnetic spark-extinguisher. The main conductor then branches off to the two platforms, each of which contains a maximum-current switch. Before the latter is reached, there are branched off the conductors for lighting and heating, the vacuum pump and the electro-magnetic rail-brake; after then traversing the measuring instruments, the current arrives at the controllers, rheostats and motors. The lighting system of each car comprises six 16-candle-power removable signal lamps, two 16-candle-power single-filament lamps for the driver's stands and thirteen 16-candle-power single filament ceiling lamps for the interior of the car. Twenty-one radiators of the Therma system, each using up about 400 watts, have been provided for heating each car.

The goods motor cars are two-axle cars equipped with two motors of the same type, thus developing half the tractive effort of the passenger motor cars. They also comprise electric lighting and heating circuits.

The passenger trailers are partly two-axle and partly four-axle cars, equipped in the same manner as the passenger motor cars. The goods trailers are either designed as postal vans or as open or closed two-axle goods vans.

As the building season was limited to a few months of the year, the construction of the railway took nearly four years. In spite of extraordinary difficulties due to weather conditions, the terms stipulated in the contract were fulfilled, almost to the day.

The density of traffic is increasing rapidly. In spite of the heavy task involved in clearing the track of snow, it is hoped, in a few years, to be able to operate the whole of the line throughout the winter.

Life Without Oxygen—II*

The Anaerobic Beginnings of Life

By Carl Snyder

(Continued from Supplement No. 1889, page 175)

The Genetic Relationship of Anaerobic and Aerobic Life.—If the simplest and most primitive of living organisms are anaerobic; if, moreover, the fundamental cellular metabolism be in all cases essentially anaerobic and oxidation and combustion, as it were, exterior or secondary processes; if finally, our faith in the reality of evolution be not somewhere lost in descending the scale of life, then it must follow that there is a genetic relationship between anaerobic and aerobic respiration; that complete aerobiosis represents an evolution from complete anaerobiosis; further, that in all probability the middle forms of this evolution may be discovered.

Such a conclusion has already been foreshadowed in the preceding section; the idea was first put forward in tentative fashion by Pfeffer as far back as 1878 but rather hesitatingly sustained in his further researches published in 1884-5. Pfeffer's facts, however, did not seem entirely conclusive even to him; and it remained for Godlewski, Palladin and their followers to establish this relationship on a firm experimental basis. Part of this work has already been noted; the main facts which speak for the conclusion may be summed up as follows:

1. That between the forms which are strictly anaerobic and those which are strictly aerobic there are countless forms which are more or less indifferently one or the other.

2. That this latent capacity may apparently be developed in a wide number of forms which naturally appear to be decisively one or the other—that is, may be "adapted" to the one form of life or the other, by passage through a suitable number of cultures.

3. That aerobic respiration appears to be simply a heightened form of anaerobic respiration, carrying the chemical process one step further and ordinarily at a much more rapid rate.

4. That many life processes, as for example the germination of seeds, may be carried a certain distance in the absence of oxygen; they then come to a stop but the processes are resumed when either oxygen or an easily oxidizable substance like sugar is supplied.

5. That the establishment of the essential part played by oxygen alike in the plant and animal economy, viz., that of a waste remover, makes clear the natural relations of these two forms of respiration and the nature of the "evolution" from one form to the other.

6. That the need of oxygen is apparently directly related to the combustion or "metabolism" of fats and carbohydrates; that both of these processes are a function of temperature and that as temperature decreases the need of oxygen sinks rapidly, so that at very low temperatures (under 10 deg. Cent.) metabolism is largely, if not exclusively of protein, i.e., anaerobic.

7. That the processes of fermentation are identical with those of anaerobic life or a yet lower term in the same genetic relationship; and that these processes, i.e., hydrolyses and cleavages, are fundamental to all vital action whatsoever and everywhere antecedent to the intervention of oxygen.

8. That if oxidation were a fundamental process, life in the absence of oxygen or of any oxygen-supplying materials whatsoever would be inexplicable, i.e., that the "adaptation" of anaerobic organisms to an oxygen "habit" is conceivable and may be understood, while in the light of our present knowledge the reverse is not.

It is perfectly clear that the relationship between anaerobic and aerobic respiration (and fermentation as well) is of the closest and represents a *continuum*. Save between the extremes of these two terms there is no sense of antagonism; on the contrary, as Bunge observes: "Apparently from the anaerobic single-celled organisms up to the most highly organized animal with the liveliest need of oxygen, we have in the animal kingdom every stage of transition." From being incessant, the need of oxygen dwindles away until it is entirely lost. At the opposite extreme we have an utter intolerance of oxygen, which in turn shades away into toleration; later condition may be cultivated apparently in the most strenuously anaerobic types.

It remains then simply to establish whether the one type or the other is fundamental and if so which is the fundamental type. If any doubt remained, it would be destroyed by the fifth of the considerations noted above, viz., the establishment of the actual part played by uncombined oxygen in the chemistry of life. Amid a quantity of admirable work, that of Verworn and his school is among the most recent and most decisive. Summing up a long series of researches, H. Winterstein concludes:

"It must be considered that in the mechanism of tissue respiration energy is primarily derived from cleavage processes of a non-oxidative nature. The products so formed (the suffocation and fatigue toxins) are then as a secondary process oxidized by free oxygen. This oxidation may follow immediately on the cleavage; it may be separated therefrom both in point of time and place; or in the case of many organisms may be suppressed for a longer or shorter time (temporary or continued anaerobiosis)."

As a conclusion to his work, already cited, Pütter makes the following observations to a similar effect:

"As a result of comparative physiological studies of the significance of oxygen in life, we may now lay down the rule that, in general, respiration is a cleavage respiration and that in the absence of (free) oxygen the energy of the organism is supplied by hydrolytic changes. The utilization of oxygen in functional metabolism, through which a much broader elimination of the respiratory materials is made possible, represents rather a specialization; this, it is true, is very widely distributed and of very great practical importance, but it should not lead us so greatly to overvalue it as to obscure the general rule, for the general rule is anaerobiosis."

From his work on the respiration of plants W. Palladin comes to the same conclusion. He says:

"As long as observers confined themselves to living plants it was always possible to talk of 'adaptations' to special conditions, such as the artificial subtraction of oxygen and offer this as an objection to Pfeffer's theory. But it is difficult to imagine 'adaptability' in *dead* plants. If dead plants are capable of producing carbon dioxide after the withdrawal of oxygen, we must admit that the same interactions take place in life, in the presence of oxygen. On the basis of these researches on dead plants, it may be regarded as proven that the process of anaerobic cleavage is the primary process in respiration and that it is brought about by enzymes."

Finally, we have a series of decisive experiments by E. J. Lesser offering conclusive proof that "the production of carbonic acid by the frog in the absence of oxygen is not due to the presence of 'stored up' oxygen as was so long believed." In other words, it seems clear enough from all this mass of work that free oxygen is not concerned in the fundamental chemical processes of the cell and that the sooner we get rid of this long-lived obsession the sooner we shall gain a clear insight into the nature of the primitive life process.

It is to be noted that in Winterstein's work special attention was paid to the relation of oxidation to the nervous system. If there be one form of tissue whose functional activity seems absolutely dependent upon a supply of uncombined oxygen it is the nerve tissue, yet Winterstein's conclusion is that "a supply of free oxygen to the nervous system of the frog cannot be demonstrated."

The researches of J. Loeb tended in the same direction. Concerning mammals and birds, Loeb states: "The blood supply to the nerves is either lacking or is so meager that we must conclude that the functions of the nerves require very little oxygen."

On the other hand, of the three main modes of animal nutrition, it is the deprivation of air or oxygen which brings death most swiftly. Unconsciousness comes more quickly still. Speck has shown that if the partial pressure of oxygen in the air is lowered to below one-third of its normal value, the fundament of mental activity, viz., the memory, is almost instantly interfered with and total loss of consciousness rapidly follows. What then is the explanation?

A multitude of experiments have shown that many of the normal products of "metabolic activity," that is of the cellular chemism, are very poisonous, often to an extreme degree. Further that *all* true proteins, whether of bacterial, vegetable or animal origin, contain a highly toxic group. The characteristic of these highly poisonous bodies is that they are in a reduced state and apparently, in proportion as they are saturated with oxygen their toxicity is lost. This seems generally true of the poisons. To cite a familiar example, carbon monoxide is deadly in almost mineral quantities, while carbon dioxide may be supported in relatively large amounts—for example, ten times that normally present in the atmosphere affects the human organism but little.

It has further been shown that it is especially the products of anaerobic activity, i.e., the unsaturated vital products, which are notably toxic and that this toxicity is diminished or lost in the case of various bacteria when they are cultivated under the influence of light in the presence of oxygen or simply exposed to the air. Of all the products of the body tissues it is apparently from those which have the least supply of oxygen, the most nearly anaerobic, that is the nerves, that the most poisonous substances come, a fact which may explain the baffling and elusive nature of neuras-

*Reprinted from *Science Progress*

thenia, the typical disease of persons who otherwise appear "well."

These general considerations have received almost conclusive demonstration from the researches of W. Weichardt. Weichardt showed that when healthy rats were put on a tread-wheel and run until they dropped dead from exhaustion, the sap or juice expressed from their muscles was highly poisonous and produced all the effects of extreme fatigue and finally death when injected into the veins of other rats. The sap from control subjects showed no such toxicity.

Weichardt found that a much larger quantity of the fatigue-poison could be obtained when the exhausted muscles were treated with *reducing* substances, while the poisons disappeared spontaneously when the muscles were given time to rest. There seems little reason to doubt from all this that "fatigue" is simply accumulated poisoning and that "rest" is simply the oxidation of these *ermüdungs-toxine* (fatigue toxins). And this is likewise the *rationale* of the effects of "fresh" air. It is not the saturated products of respiration, like carbonic acid, which, as was so commonly believed, make us drowsy in a closed room, but the almost infinitesimal quantities of other substances which are given off from the lungs; it would seem even from the woodwork and other organic substances of a room.

In the light of all this, the relaxations of anaerobic and aerobic respiration become very simple and clear. In the lowest and most minute of organisms the proportion of surface to volume is of course at the maximum and the number of individual living units interacting within the single cell is at the minimum. Some interesting researches of Errera and of MacKendrick indicate that the number of these living molecules in the simplest organisms may not be over a score or more and perhaps less. Obviously the chance of an interchange of their products with the surrounding medium, which is the very essence of life, will be far greater in the single-celled organisms than in the multi-cellular organism with its pipes and tubes. In the latter the chance for accumulation of by-products and therefore the need of a swift and effective neutralizer, like oxygen, will be correspondingly greater.

We seem to have here a simple picture why it is that the oxygen-need should increase with complexity of organization. The differences shown by organisms, high and low, of about the same grade of organism would appear to be due to those differences of chemical composition which present-day research, especially the "biological" or precipitin action, have disclosed.

To be continued

Civil Engineering Work in the Tropics*

Advice from One Who Has Had Experience

By Wm. J. Millard, Mining Engineer, Societe Internationale Forestiere et Miniere du Congo

The tropics are usually painted as being extremely unhealthful, as being full of swamp, bad water and diseases. It would be nearer the truth to restrict the general designation "tropics" by the phrase "certain parts," for the high plateau of Guatemala, for instance, is to my way of thinking one of the most healthful places in the world. On the other hand, some of the swamp along the Equator in Central Africa is, perhaps, the most unhealthful. Bad water in the lowlands may always be made palatable and non-injurious by boiling. Water in the mountainous regions is usually pure and clear. The white man is more susceptible to some of the prevailing diseases than is the native; but the native is more susceptible to the majority of diseases because the white man's habits are cleaner. If the American engineer will take the proper precautions, he stands a very good chance of coming back from a six months' or two years' trip in good health.

A stock phrase is, "The greatest bane of the tropics is malaria." It usually takes six months for a white man to become thoroughly soaked with malarial germs and then his troubles have surely commenced if he neglects quinine. I have found by actual experience that by taking two grains of quinine daily in Central America and five grains daily in Central Africa, one is not troubled with the fever. If every man who goes to the tropics will start taking quinine from the time he enters the torrid zone until a month or two after leaving, he will never suffer from the trouble. Of course, quinine has some deleterious effects. One gets "nerves" and also acquires a temper that is easily aggravated. But "nerves" and temper are preferable to the periodic attacks of fever, which continue to lessen the vitality until an attack of some other disease, to which the white man in normal health is immune, carries him off.

Since the mosquito carries the malarial germ, it is necessary to sleep under a mosquito bar at night. There are places in the tropics where the mosquito is unknown, as, for instance, in parts of the mountains of Nicaragua and Guatemala. The presence of the mosquito depends on whether there is any standing water. In Africa one finds mosquitoes at an elevation of 6,000 feet above sea level on account of standing water in swamps.

There are other common diseases in the torrid zone such as dysentery, caused by unclean food, and typhoid, caused by bad water. These causes can be easily remedied by raising Sam with the cook and by boiling and filtering the water. As I said before, running water in the mountainous regions is usually drinkable without boiling and filtering.

It is absolutely necessary to refrain from sleeping on the ground. Most engineers who travel in the American tropics carry a folding cot. For bedding one should take at least two army blankets, as the temperature in many places has a daily range of 30 degrees. A pillow is a luxury not to be indulged unless it be one of inflatable rubber. In Africa one carries a bed box containing folding bed, mattress and pillow. As a man usually goes to Africa for two years and never sleeps in a hotel, these luxuries are perhaps permissible. In the American tropics, on the other hand, one sleeps in a hotel occasionally. Then, too, because most of the baggage is packed on mules instead of negroes, the baggage must be extremely limited.

In Central America field luggage should be limited to a sailor's canvas duffle bag, which will carry cot, blankets, underwear, clothes and shoes. This bag, about 3½ feet long and 18 inches in diameter, makes a convenient side pack on a mule. The Gold Medal cot will go into the bag nicely. I have mentioned blankets. It is well to remember that the temperature upon going to bed may be 86 deg. Fahr. and upon arising may be 56 degrees. I find that athletic underwear is the most comfortable; but must be accompanied by a flannel overshirt, preferably the olive-drab shirt of the United States army.

Flannel overshirts are very necessary. One is likely to be caught in a heavy rain, be thrown off a mule into a creek or get thoroughly wet going through old drifts. Flannel will prevent the sudden shock that results from exposures of this nature, which are dangerous in the tropics. Flannel bands are recommended by some to protect the abdomen. I protest against them, because they do more harm than good. If left off for one day or one night, the result may be very serious. The sickness that prevails among natives does not result from lack of wearing a *ceinture*.

Shoes and trousers should be gaged in quality according to the length of stay. It seems superfluous to recommend khaki cloth for trousers, but it is a fact that some engineers have taken corduroy trousers to the tropics. A pair of mosquito boots should be included for wear after sundown. To my knowledge these very useful articles of footwear can only be purchased in Europe at present. Stetson hats make good headgear for Central America.

As tropical mules are small and Spanish saddles are contraptions of the devil, it is well to take along a McClellan saddle, which can be made to fit the mule's back by the use of pads. An oilskin slicker should be carried in the saddle in preference to a poncho. The shaving outfit, etc., may go into the saddle bags.

One may carry a six-shooter into Central America, although a bond will have to be given at the custom house. Central America is very suspicious of all firearms. It is easy to avoid suspicions and delay by going ashore with your gun in your trouser leg. One of my friends neglected this little care on one occasion and consequently his six-shooter (the Spanish official called it a cannon) was not seen by him again for six months. A gun is necessary, because it will assist in getting fresh game. Then, too, there are jaguars and plenty of snakes in some parts.

It would be fitting at this point to make a few remarks and suggestions about treating snake bites. Where snakes are bad, always carry a small vial of potassium permanganate tablets. A small tablet will neutralize the poison. A ligature is bound above the wound, the wound is slashed with a knife and a tablet of potassium permanganate is crushed and sprinkled in the cut. Then the ligature is slowly released. It is also advisable to sip slowly a solution of potassium permanganate. This method of treatment was given me by an American doctor who has resided several years in Nicaragua. That it will cure was corroborated by a doctor in the employ of the United Fruit Company in Panama. He stated that he had saved the lives of many negroes who had been bitten by the *tabowa*. Some of his cases were 24 hours old.

Returning to the subject of equipment, the engineer bound for Africa doubles his amount of personal clothing and takes several things in addition. The transportation facilities consist of river steamers, railways, canoes and porters. Once well within Central Africa, most of the packing is done by blacks. The average load for two of them is about 75 pounds. As the climate of Africa is hard on clothes, it is best to make use of the small *malles à fer*, made especially for African service. One of these trunks may be in the form of an oval bath tub. In addition to clothes for the field, it is wise to include a few suits of white military-cut clothes. One has need of them in traveling on the river steamers, on the railroad and paying respects to Europeans in charge of the military posts.

A Stetson hat may be taken for use only up to 8 o'clock in the morning and after 4 o'clock in the evening. During the intervening hours it is absolutely imperative to wear a helmet. While in Central America one may go bareheaded in the sun, a short exposure to the African sun will result in a headache that will last two or three days. Continued exposure will result in sunstroke and death. Cloudy days are particularly dangerous. The helmet best suited for field work is the "General Woolsey," of a khaki color and made in England.

A 6 x 8-foot tent and fly are necessary for each man. In addition one should take a folding table, two camp chairs, a rifle, a shotgun, a revolver and a small tabloid medicine chest. While most of these things are unnecessary in Central America, they are very necessary in Central Africa, where every comfort is worth its weight in gold before the two years have passed. One only needs to make a 15-mile hike on foot under a blazing sun to appreciate the comfort of a camp chair at the end of the journey.

It is necessary in Africa for each white man to have two servants, a cook and a boy to make up his bed, wash clothes, set the table, etc. A man will find that he owes a great deal of comfort to these black boys, although you may have a little trouble for the first two weeks. One must learn the language. The dialect varies from place to place, and causes some confusion. For instance, one night, feeling cold, I sent my boy after my overcoat. He brought me instead a 50-foot steel tape!

Fresh vegetables, chickens, eggs and goats may be purchased at any native village. One passes through two or three villages a day in traveling along the caravan routes. In the dry season there are many antelope, buffalo and small game that make welcome additions to the table. The food problem of Central America, on the other hand, is easily solved on account of the large number of small towns and mining communities.

With regard to work, if an engineer is in Central America for three months only, he may work as hard as he does in the States. If he is going to be in the tropics for six months and more, he must not work as hard as in the temperate zone. A man will soon run himself into a wreck if he overexerts himself. It is not possible to do the amount of either physical or mental labor in the torrid zone. This is a statement that very few Americans will heed until they have had the sensation of going under as a result of overwork.

Life and work in the tropics, on the whole, are not bad and are very interesting. There are discomforts and inconveniences, but these are found everywhere. For the engineer who has once been in the tropics there is always something irresistible that brings him back to them. He swears time and again that if he ever gets out and back to old New York, nothing will ever make him go back. Still, after two months of office work and city recreations, one morning you will find him on the deck of an outbound ocean liner.

* Reproduced from the *Engineering Record*.

For the production of the sixteen hundred million post cards mailed annually in Germany, about 600 carloads of cardboard are required.—*Umschau.*

The Boland Tail-less Biplane*

Complete Description of an Original American Aeroplane

After experimenting with power machines since 1908, flying, smashing, altering, with the one object in view of proving that rudders as generally used are unnecessary, that ailerons and warping wings are only two methods of keeping right side up, Frank E. Boland of Rahway, N. J., has demonstrated during the past summer that he can fly as well as anyone. Some exhibition flights were made on October 21st, 1911, for the benefit of a number of interested persons who had assembled for the purpose of seeing the machine in flight.

Boland's flights all along have attracted a lot of attention among the flying colony on Long Island, but little information has spread abroad. Nothing new startles aviation "fans." There is no grand stand play about Boland's flying. He just gets in the machine and off he goes, turning as he leaves the ground, if he likes, which no other aviator thinks of doing. He just imagines himself in an automobile and drives accordingly. He says he never bothers about lateral balance or other minor things like that. His seat, with stirrups for his feet, is so secure that nothing can throw him out. He just turns his steering wheel to go to the right or left and pushes or pulls it to go up or down. If one side of the machine does get too low, he just turns the wheel to the opposite side and he is level again. He put a tail on one day, found it did not fly as well and took it off, all without rebalancing.

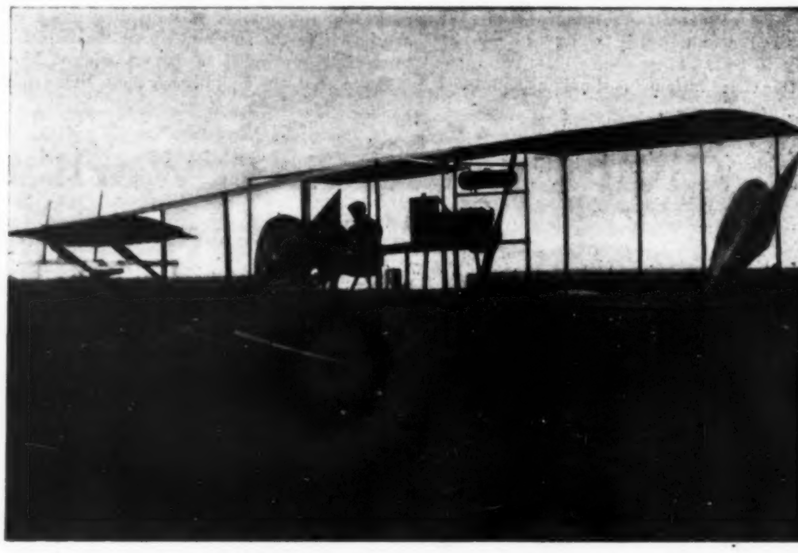
Main Planes.—The span is 29 feet 6 inches, the chord and separation of the planes being 5 feet 6 inches. The central section is built up as a unit, the uprights running from the skids to the top plane. The wing spars of the outer sections butt against these struts and are secured thereto by clips of sheet steel. The covering of the planes is single, the ribs running in pockets sewed on the upper side. The main spars are also run in pockets, the ribs being attached to the top of the front spar and to the bottom of the rear, as in the Farman machine. The curvature of the ribs is very slight—only ½ inch deep about half way between the spars. The trailing edges of the ribs are straight as originally bent, but they are very flexible, ½ by 1 inch solid ash, tapering to a point at the rear. Here they probably take some reverse curve, due to the pressure of the air. The plane flies as it stands on the ground, with scarcely any angle of incidence, the ends of both front and rear spars being the same height from the ground.

Elevator.—The elevator, pivoted 14 feet in front of the main plane, has a span of 13 feet 2 inches and a chord of 3 feet. It is single covered and has a very pronounced curve—2½ inches. When in horizontal flight this is held at a very flat angle. The surface is strongly stayed by wires running from the two steel-tube masts to which the wires from the steering frame are run. The front spar is formed of a piece of ¾-inch tubing, the rear being of spruce.

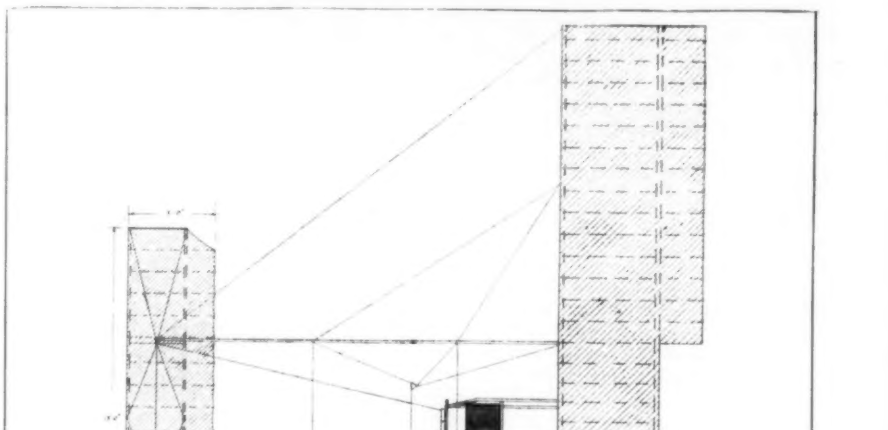
Controls.—The main point of this machine, and the one which gives it its claim to attention, is the absence of both rudder and ailerons. To take the place of them, a pair of "jibs" is used, and these are situated at each lateral end of the machine. Each works in one direction only and both are controlled from the hand wheel on the steering column. According to Mr. Boland, the operation of the machine is the same as that of an automobile, with the exception of the elevator, which works in the accepted manner. In order to turn to the left, the wheel is turned to the left, the machine swinging around easily and banking itself properly. When the turn is complete the wheel is brought back to center and "that's all there is to it." The jibs are triangular in shape with a balancing portion, and are pivoted at the points *A* and *B* as shown in the sketch, the wire *C* from the wheel going to the lower corner. When the wheel is turned, the lower corner of the jib is pulled in, thus presenting an obliquely inclined surface, offering resistance on that side. A throttle lever is operated by hand.

The seating of the aviator is novel. The feet are not used for any purpose whatever and are inserted in "stirrups," or loops made of wire in the guying of the outrigger framing, so that the man sits in much the same position, with the knees high, as the driver of a racing automobile. In case of a rough landing, it is almost impossible for the aviator to be thrown forward on his face, nor can he fall forward on his steering column, preventing him from pulling back on his elevator. A picture taken of the late Louis Rosenbaum shows him leaning so far forward on his steering column that the elevator is depressed and he has nothing to push against to regain an upright position in his seat.

Running Gear.—While this, as originally designed and as shown in the drawings, consists of four wheels, Mr. Boland has since modified it so that but two 26-inch wheels are now used. These are mounted on the ends of a long axle placed above the skids at a point slightly in advance of the front edge of the main planes. The axle is held against the skids and made to carry the weight of the machine by means of four steel cables that pass over it in special grooved disks,



Three Quarter Front View of Boland Biplane. The "Jib" on the Right of the Photograph is Pulled in to Steer to the Aviator's Left, or to Depress That Side.

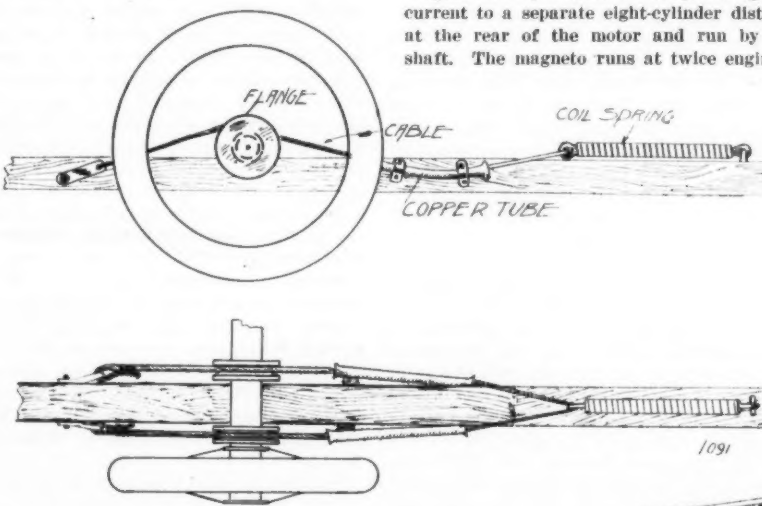


Plan and Front and Side Elevation of The Boland Biplane.

* Reproduced by courtesy of the Editor of *Aeronautics*.

and attached to two coil springs, as clearly shown in one of the drawings.

A recent improvement consists in fastening one end of the spring to a hooked trigger, that can be released as soon as the machine lands. This takes all weight off the wheels, and the skids quickly stop all forward movement of the biplane.



Drawings Showing Mounting of Axle on the Skids.

Power Plant.—An eight-cylinder "V" motor of Mr. Boland's own make is used. This has stood the test and runs right along with very little tinkering. The cylinders are 4 x 4 inches, brass water jacketed on the sides, the heads not being jacketed. The valves are concentric, and are located in the cylinder head, only the exhaust valve being mechanically operated. The oiling system is a combination of force feed and splash, with oil well in the base.

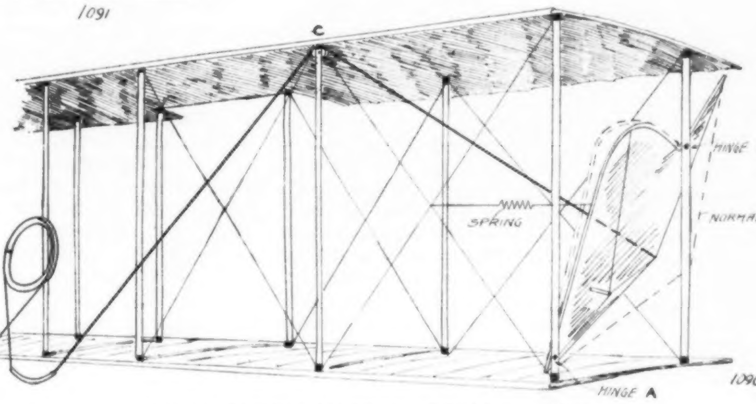
Unique construction is noticed in the nickel-steel crankshaft. This is "built up" of five members. One connecting rod is forked at the crankshaft end, the other one fitting between the forks. The cylinders and connecting rods are not staggered in this method. The special system of connecting rod bearings allow both rods of a pair to get full advantage of a wide bearing—2¾ inches. The cranks are steel disks, bored for lightness. The weight of the engine complete with carbureter, magneto and oiler, is 230 pounds. The crankshaft alone weighs 34 pounds.

Ignition is by a Bosch motorcycle magneto, delivering current to a separate eight-cylinder distributor, placed at the rear of the motor and run by the oil pump shaft. The magneto runs at twice engine speed. The engine runs normally at 1,200, giving 60 brake horsepower.

The oil enters the hollow crankshaft, is forced into the connecting rods and line bearings, then splashes the cylinders. The one-piece connecting rods are hollow chrome nickel steel, cut from a solid forging. There are oil pits under each connecting rod so that any change in the level of the machine will not drain oil away from the high end of the engine. The cam shaft is mounted on R. I. V. ball bearings and a big bearing of the same make is used for the center bearing of the crankshaft. The other crankshaft bearings are solid bronze, slipped over the ends. There is no provision for take-up on these, as very little wear has thus far been discovered. They are larger than usual and a better pit is secured by their being solid. A ball thrust bearing is used on the propeller shaft. This is tapered and a special hub is keyed to it. The propeller is bolted to a flange on this hub. A Livingston radiator is used for cooling.

The pistons have three cast-iron rings, with a large oil groove in line with the piston pin. The cylinders do not carbonize.

Weight.—The weight is given as 740 pounds, including aviator, and the speed is from fifty to sixty or more miles an hour.



Drawing Showing Manner of Operating the Jibs.

Deflocculation*

By EDWARD G. ACHESON, Sc.D.

HAVING worked out the problems involved in the manufacture of graphite from coal and other carbonaceous materials, I undertook, in the summer of 1901, the introduction of this artificially made graphite into the crucible trade. My first efforts were devoted to the making of a satisfactory crucible of my graphite, using as a binding material American clays. Many failures were met with, and I found it difficult to locate the cause of the failure, whether with the graphite or with the clay. I soon learned that the manufacturers of crucibles in the United States invariably used as a binding agent for the graphite in the crucible body, clays imported from Europe. I secured samples of these imported clays, and found them much superior to the American ones in plasticity and tensile strength.

Chemical analysis failed to disclose the cause of the physical differences existing in the clays. The question involved interested me greatly, and I decided to endeavor to determine what produced the variations. I found it generally stated in the books that residual clays were non-plastic, and sedimentary clays were more or less plastic. Here was the starting point. Plasticity was developed by or during the act of transportation from the point of formation to the final resting place of the clay. I did not believe there was anything in the simple act of the suspension in water that would produce the effect noted, and therefore looked for the cause of the foreign matter carried by the water. It seemed the most likely agents were the organic substances washed from the forests into the running waters. With this idea in view, I made a few experiments with those substances I thought likely to be found in the washings of vegetation. One of my early experiments was to treat kaolin with a solution of tannin, and I at once noticed less water was needed to produce a given degree of fluidity; also that the tensile strength and plasticity were increased.

Tests were made on the increased tensile strength of clay, as the result of treatment with organic matter, and it was found that briquettes made of Harris kaolin and dried at 120 deg. C. would break with a load of 5.73 kilogrammes per square centimeter, while the same clay, after treatment with 2 per cent of catechu for a period of ten days, then formed into briquettes and dried at 120 deg. C., would not break until the load was increased to 19.75 kilogrammes per square centimeter—an increase of more than 244 per cent.

I now began to wonder whether or not the effect I had discovered was known, as it might have much value to an industry of such colossal dimensions and antiquity as clay working. Moreover, it would be amazing if it should not be known, in view of the tremendous amount of experimental work that had been done on that art. I searched for some record of the addition of organic matter to clay during its working, and only one instance could I find, that of the Egyptians in brick-making, as recorded in the fifth chapter of Exodus. The accepted theory of using straw fiber as a mechanical binding agent had never appealed to me. Straw, however, contains no tannin, and the effect I had found had always been produced with tannin, or a substance containing tannin. I procured some straw, boiled it with water, decanted the resultant reddish brown liquid, and mixed it with clay. The result was like that produced with tannin, and equal to the best I had obtained. It now seemed likely that the Egyptians were familiar with the effect I had discovered, and believing this was why they used straw in making brick and were successful in substituting stubble for the straw, I called clay so treated "Egyptianized Clay."

In the summer of 1906 I succeeded in making artificially a high grade graphite which I wished to make applicable to all kinds of lubrication. To meet the various demands, it would be necessary to have it remain diffused in liquids lighter than itself; for instance, water and petroleum oils. Recalling the effect of tannin on clay, which caused it to remain diffused in water, I treated a sample of my graphite with tannin, and found the same effect occurred.

The actual amount of deflocculating effect produced on the graphite is very small indeed. In commercial work considerable mastication and time are required.

Upon being deflocculated, the graphite is diffused through the water in a colloidal state, and I have samples of deflocculated graphite in water which have stood for more than two years without showing any settling, notwithstanding the fact that graphite is two and two-tenth times heavier than water.

I have been able to obtain this same effect in natural graphite, amorphous alumina and silica, lamp black, and my manufactured product siloxicon, which is an amorphous body having the formula Si_2C_2O. The effect can be produced with a long list of organic bodies; for instance, tannin or organic substances containing tannin, also with solutions containing the gum of the peach and the cherry tree, or extracts from straw and grass. The offal from the barnyard proved to be very efficient. I speak of these organic substances as agents when used to produce deflocculation, and they act as protective colloids to the deflocculated body.

As I have already stated, I deflocculated clay in the year 1901 and graphite in 1906 and immediately afterward a number of other bodies. I early understood I was producing colloidal conditions of these bodies, but not until the summer of the past year, 1911, did I read any treatise on colloids, being familiar with this state of matter only in a very general way. During the summer I procured a copy of the book "Colloids and the Ultramicroscope" as written by Dr. Richard Zsigmondy and translated into English by Jerome Alexander of New York. I found the book extremely interesting, and at once wished to have a sample of my deflocculated graphite subjected to ultramicroscopic examination. Mr. Alexander kindly undertook the examination. He found the graphite in the deflocculated condition to be in a true colloidal state, the particles being in rapid motion, and he estimated their average size in linear dimensions to be 75 millimicrons. Seventy-five millimicrons are seventy-five millionths of a millimeter, and it would require slightly more than 13,000 of the particles to extend one millimeter. Now, the particles of disintegrated graphite, used as the crude material from which to produce deflocculated graphite, pass through a filter having 40,000 meshes to the square inch, and their maximum linear dimensions are such that it would require thirteen of them to extend one millimeter. Hence, the particle of disintegrated graphite is one thousand times greater in linear dimension than the deflocculated one. These are figures that certainly test our powers of appreciation.

* Abridged from a paper read before the Society of Chemical Industry.

The First Subway in Italy.—The first city subway in Italy is, according to a consular report, to be constructed at Naples. The estimated cost is 30,000,000 lire ($5,790,000), to be met entirely by the concessionary company and without subsidy or grant of any kind. The capital is largely French. The line will be both urban and interurban, the former with a total length of eight kilometers (4.97 miles) and the latter ten kilometers (6.21 miles), and is to be completed in four years. Similar projects are under consideration both at Genoa and Rome, but thus far the Naples subway is the first in Italy upon which definite action has been finally taken.

Fire Extinction by Frothy Mixtures

A Record of Some Very Successful Trials of the New Method

Short of explosive substances, probably no materials present greater fire danger and a more acute problem to the fire-fighting department than volatile and highly inflammable liquids, such as benzine. Of recent times a new weapon has appeared on the field for the attack of conflagrations of this character, in the form of froth produced by suitable means and spread over the surface of the liquid. An account of some very important tests of this new method is given in a recent number of *Engineering:*

"The compound is the mixture of two liquids which are kept separate until used. The one liquid is a soda lye containing froth-forming ingredients; the other is a solution of alum, etc. Both liquids, it is claimed, can be kept exposed to the atmosphere, and require only that the water lost by evaporation should be replenished. The solutions will stand a fairly low temperature, as they do not freeze until the thermometer has gone down to —5 deg. Cent. (23 deg. Fahr.). The foam consists of bubbles filled with carbon dioxide.

"In the official experiments the mixture of 1 liter (about a quart) of each of the two liquids yielded 15 liters of froth without any liquid residue; the volume ratio was 2:15 or 1:7.5. In a cylindrical vessel 28 centimeters (11 inches) in diameter the 15 liters of foam lost in four minutes 4 per cent in volume, in 10 minutes 10 per cent, in 30 minutes 41 per cent and in 60 minutes 67 per cent, the foam being thus in one hour reduced to one-third of its original volume. When the frothy mixture was poured on to water, it yielded only 11 liters of foam, which proved more stable, however; the volume was not reduced during the first 10 minutes; after 20 minutes a loss of 8 per cent was observed, after 30 minutes a loss of 20 per cent and after 60 minutes a loss of 45 per cent, so that there remained 6 liters of foam after one hour. Poured on to benzine—using this somewhat indefinite term to indicate highly inflammable hydrocarbons—the 2 liters of liquid yielded 13 liters of foam, which settled a little more quickly; it lost in 5 minutes 5 per cent of its volume, in 10 minutes 14 per cent, in 30 minutes 47 per cent and in 60 minutes 76 per cent, leaving 3 liters of foam after one hour. These results were confirmed by experiments in which water or benzine was sprayed on the layer of foam through a rose. When benzine was covered by a layer of foam 6 centimeters (2.4 inches) in thickness at 8 deg. Cent. (46 deg. Fahr.), the benzine could not be lighted for the first 3 minutes by holding a lighted match over the foam. The foam began to collapse afterward, and some vapor escaped which could be lighted; but the flame did not spread till after 12 minutes. When sucked up, the frothy mixture escaped from the hose as a continuous jet of foam, which, falling obliquely on water, first formed a lump of foam, which gradually spread over the whole surface. The same phenomenon was observed when the foam fell on burning benzine, which was extinguished in 42 seconds. Remeasured immediately afterward, the foam layer was found to have lost 42 per cent in volume by being squirted and heated.

"So far the first preliminary tests. In the large experiments various objects were used. A large circular brickwork tank for oils, etc., 10 meters (33 feet) in diameter, all surrounded by earth, was filled with combustible liquids to a depth of 0.6 meters (2 feet). Another iron tank, 2 meters in diameter, 2.6 meters (8½ feet) high, was surrounded by an earth mound of 5 meters (16 feet) radius. There was, further, a brickwork structure, open above, covering 3.75 square meters (about 40 square feet), serving as an imitation cellar for storing benzine casks, etc. Finally a tar field of 1,300 square feet area. The respective fires were extinguished with stationary and with portable apparatus. The stationary plant was of two kinds. The simpler plant *a* comprised two cisterns, for the orginal liquids, placed about 5 feet above the ground; 26-millimeter (1 inch) pipes joined these cisterns to the mixing pot, and to the cellar mentioned; the liquid flowed under the action of gravity. The larger plant *b* was provided with two vessels, each of 5 cubic meter capacity (175 cubic feet), and two duplex feed pumps, capable of supplying about 160 liters (42 gallons) of liquid per minute to the mixer, which was 80 meters from the great benzine tank; the pipes were 52 millimeters (2 inches); the foam was taken by an 80-millimeter pipe to the large tank, where the pipe was split into two 2-inch pipes. The portable apparatus consisted of two Perkeo pumps; the one, a Perkeo tilting ejector *c*, carrying 150 liters of liquid, which mix when the tub, which runs on two wheels, is tilted The other, the Perkeo gas pump *d* was a tub of 600 liters (158 gallons) capacity, which is subdivided by a vertical partition and requires artificial propulsion; the carbon oxide wanted for forcing the foam jet through the hose is obtained from a cylinder or from another part of the plant.

"The foam stream given by the *a* plant (small, portable) killed in 1 minute 18 seconds a big petroleum fire started by lighting some benzine, which on burning burst some oil casks. Five minutes later the foam layer, which had a thickness of about 2 inches, was swept away, when the liquids would readily burn again. The stationary plant *b* gave, with a pressure of 4 atmospheres (or about 60 pounds per square inch) in the mixer, a steady, coherent jet, 100 feet in length, which settled as a foam layer. When the pressure was reduced to 1 atmosphere, the jet became reduced to 40 feet. The large 10-meter tank was filled with benzine, of which 450 kilogrammes (1,000 pounds) were floating on water. The liquid was lighted, and after burning 2 minutes 15 seconds, the jet was applied under a pressure of 2 atmospheres. The falling foam made the burning benzine splash badly, but the fire was extinguished in 2 minutes 26 seconds; 630 liters of foam were used, and the layer had, after 15 minutes, still a thickness of 5 centimeters (2 inches). The benzine under the foam could afterward be relighted.

"In a subsequent test 15 tons of crude benzine were lighted in the same tank, and produced enormous smoke clouds, of course. After the fire had lasted 5 minutes, the foam was turned on under 2-atmosphere pressure. There being a strong wind, the violent agitation of the burning liquid by the foam stream could be watched on the one side of the tank. The spreading foam layer stifled the fire, but there remained, at first, some isolated flame jets, especially near the edge of the tank. In six minutes the fire was extinguished. Ten minutes later the liquid would at once relight when the foam had been swept away. The layer had a thickness of 2 inches five minutes after extinguishing the fire, which consumed nearly 1 ton of crude benzine. About 1,800 liters (475 gallons) of liquids had been used; some 4,000 liters (roughly 1,000 gallons) of foam must have been floating on the benzine immediately after extinction of the fire, and two-thirds of the original volume of the frothy liquid were lost owing to the use of the hose and the exposure of the foam to the air and flames. The experts concluded that the frothy liquid should be applied under small pressure, so that it may spread quietly without causing splashes and eddies which would rekindle the already stifled flames. The number and dimensions of the pipes and hose should be selected so as to insure a quiet discharge of the frothy liquid.

"In dealing with benzine fires produced in the iron tank of 2 meters diameter, which was surrounded by a ring space 3 meters in width, filled with 400 kilogrammes of gas oil, use was made of the stationary plant *b* and also of the gas ejector *d*. The *b* pumps killed the big fire in the ring, which had been burning for two minutes, in 35 seconds; after which the gas ejector stifled the flame still burning in the tank itself in 13 seconds. In both cases, as in those previously mentioned, enough benzine or oil was left after extinction of the fire to flare up again when relighted, immediately after removing the foam layer floating on the oil. In experimenting with the tar field, 1,300 square feet in area, the field was charged with 1,800 kilogrammes of tar and four empty tar barrels; to start the fire 150 kilogrammes of spirits had been sprayed on the surface. When the fire had been burning for four minutes under evolution of huge clouds, and when it was assumed that the highly volatile benzine, etc., had been consumed, and that it was essentially the tar itself which was burning, the hose of the tilting-pump *c* was applied. The hose had a length of 20 meters, and the froth issued from a 32-millimeter hose through a 13-millimeter (½-inch) nozzle, under a pressure of 3.5 atmospheres. The flames were suppressed in 1 minute 35 seconds. This performance is not less remarkable than the others, considering that the portable tub does not hold more than 33 gallons of liquids, and this charge was not quite used up in extinguishing the tar fire.

"It would thus appear that huge oil and spirit fires can be dealt with by this system, with the aid of installations such as would not unduly complicate petroleum tank plants, oil and spirit stores, docks, etc. Some provision must be made for fire extinction in all these cases, and the additional cost would probably be moderate." The outlook for the future development of the new method seems most promising.

Water Purification

In a paper recently presented to the French Academy of Sciences, E. Rouquette discusses the purification of water for municipal consumption by the use of certain chlorine compounds and other oxidizing agents. The use of chlorine compounds in particular has been put to a practical test in a number of towns of England and Belgium, with very favorable results. Among such compounds employed are to be mentioned so-called "chloride of lime," and the hypochlorites of sodium and potassium, to which ferric chloride or aluminium sulphate may be added.

Last summer a trial was made with the water of the Marne, purifying it by means of hypochlorites for use in Paris, where an extra supply was needed at the time. During the cholera epidemic in Marseilles in August, 1911, the origin of which was traced to contaminated water, the author used sodium hypochlorite for purifying water highly charged with cholera germs through sewer infiltration. As the result of the trials it is now possible to give reliable data as to the amount of active chlorine to be used for water treatment in proportion to the amount of organic matter. It is found that the best proportion is one part of chlorine to one million parts of water containing one part of organic substance. The chemical added in this small proportion is found, by prolonged observation, to have no ill effects on the human organism. Bacterial analysis shows that in water originally containing 15,000 colon bacilli per liter, after treatment no bacilli could be found in 100 cubic centimeter sample.

The author has studied the following points: (1) The difference in the oxidizing action of various substances containing loosely bound oxygen and chlorine; (2) the relation between the nature of the substances employed and the rate of disappearance of the secondary products found in the water; (3) methods of preparing the purifying compounds.

The author's conclusion is that the best purifying action is obtained by using simultaneously sodium persulphate and hypochlorite. In place of this, however, a mixture of sodium bisulphate and hydrogen peroxide may be used, which gives rise by mutual interaction to the substances mentioned. When the two agents are used together, as indicated above, very perfect oxidation of the organic matter is found to take place, and at the same time the disease germs are destroyed. This mixture seems to be the best yet discovered for water purifying purposes, and the dose employed may be reduced as far as one part in five million of water. There is no necessity for filtering the water before treatment, and after treatment no harmful product of any kind is left in the water, nor is any insoluble matter deposited, and the water remains clear, colorless and tasteless.

In practice, the treatment is very simple of execution, the water to be treated being introduced at the bottom of a mixing basin. The purified water flows off at the top, and no mechanical mixing is necessary. The author's opinion is that the present process is not only very readily carried out, but is also economical and thorough, a matter of no small importance in dealing with water supplies for cities and towns which are not equipped with proper filtering or purifying plants and where, in case of an epidemic, immediate steps have to be taken, and of course it is out of the question to rely on the installation of new purifying plants, as this would involve far more delay than permissible in such circumstances. In such cases of emergency the process is found most valuable for destroying cholera and typhoid germs and the like. In point of economy it certainly stands high, as the required equipment is reduced to a minimum and the running expenses also are very low. The method can be applied anywhere in conjunction with existing methods of water supply.

Lacquer for Gutta Percha.—Mix and grind down in an iron mortar 50 grammes manila copal, 55 grammes bleached shellac and 45 grammes mastic. Place the powdered mixture in wide-mouth bottle and add 1½ liters of spirit (95 per cent); cork up and allow to stand aside for three hours, shaking the contents occasionally. Then add 16 grammes Venetian turpentine, cork again and let stand aside for a while. Filter if necessary. Shake before using and apply in a thin coating. Allow to dry slowly.—*Gummi Zeitung.*

The Sense of Smell*

Its Limitations and Peculiarities

By Dr. R. Foerster

As man feeds in general upon only a limited number of natural products that are well known to him, being mostly specially cultivated, the chance of his erroneously confusing harmful products of Nature with these is not likely to happen very frequently.

With the human race, therefore, the sense of smell does not play a very important rôle in the discrimination of one food from another. It has taken a subordinate place as an organ of sense, being largely replaced by other faculties, particularly those of the eye and touch, as well as by reason, judgment and experience.

The use of the eye in place of the nose was to a certain extent a consequence of the assumption of the upright posture, which gave man the advantage of a wider field of vision, but at the same time deprived him of the earth's proximity and what was to be gained from it.

The smallness of the central organ of smell in the brain of man when compared with its relative importance in that of animals is in keeping anatomically with this altered carriage. It is a general rule in the animal kingdom that the organs most used correspond with large sections of the brain, so that from the development of particular parts of that organ, e. g., of the olfactory center, the degree of activity of the respective sense can be gaged.

While therefore an animal depends very greatly upon its sense of smell for selecting its food, being exposed at every step to life-endangering toxic agents, the same sense in our species is called into use much more rarely for distinguishing suspicious articles or appreciating agreeably smelling ones.

Whether smell exerts a deep influence upon the enjoyment of life is not certain; the sequence of our thoughts is directed by a variety of causes, many of which are unknown. Often sounds affect our chain of reflections, and odors are also effective, frequently bringing up reminiscences, perhaps depressing or exhilarating us. Rousseau attributes to smell the power of stirring the imagination.

The effect upon a hungry man of the smell of appetizing food is at any rate most clearly marked.

It has been supposed that dark persons have a keener olfactory sense than their fairer brethren, and among animals as well as human being albinos are said to be specially defective in the power of detecting odors. Black pigs are said to be bred in Virginia in preference to those of lighter hue on account of the lesser risk of poisoning from *Lachnanthes tinctoria*, and black sheep in Tarentino because the white ones poison themselves with *Hypericum crispum*. Hack considers these examples as doubtful, however, for albinos are known to be less resistant to toxic substances than are other persons, and Aristotle has pointed out the greater susceptibility of white as compared with black pigs to the bite of scorpions.

A smell becomes appreciable when an odorous gas or vapor comes in contact with the projections of the olfactory nerves in the upper part of the nose. These nerve endings have hair-like extensions projecting into the nasal cavity.

We are not yet quite sure that a liquid can be smelt, for on lowering the head sufficiently to allow the nose to be filled with fluid, we cannot be positive that some air space may not be left from which vapor may reach the nerves, so that any odor experienced may be due to the vapor and not to the fluid. But that smell can be detected in water is shown by the development of olfactory nerves in fishes.

Rinsing with dilute solution of permanganate of potash creates a certain sense of smell, which, however, arises possibly from particles of skin chemically changed by the permanganate, and a similar explanation would account for the sensation caused by the action—a destructive one—of caustic alkali.

The olfactory nerves are rendered useless for an hour by simply rinsing with cold water, and other fluids may destroy their efficiency far more. The anatomist Hyrtl who drew an infusion of tea into his nose with the idea of curing a cold, suffered loss of the power of smell for six months, and throughout his life never completely recovered it.

From the nerve endings the sense of smell is carried upward through the sieve-like bone—the cribiform plate—to the olfactory lobe, an outgrowth of the brain. Although the connection between smell and the olfactory lobe cannot be doubted, there have been cases in which the transmission of the sensation must have taken another course. Claude Bernard made a post mortem examination of a woman who was found to have no olfactory nerves, whereas in life she had been a successful cook and well able to detect odors. She had a strong objection to tobacco smoke, for instance. It is not impossible that in her case the sense of taste together with a specially sensitive mucous membrane took the place of the olfactory nerves. As with other senses, smell may on occasion be replaced by higher development of neighboring organs.

To detect an ordor it is necessary that there should be a movement of air in the nasal cavity. Unless one breathes one cannot smell. The odor of an object brought close to the nose during a respiratory pause may, it is true, be recognized after withdrawal of the object; but in such cases it is the odorous vapor left behind in the air that renders itself apparent.

The course taken by the inspired air between the complex nasal muscles has been ascertained upon a corpse by causing ammoniac air to pass through the nose and out through the larynx, the nasal cavity being previously carpeted with small fragments of litmus paper.

Wherever the paper turned blue are air must have penetrated. In another experiment the discoloration produced by smoke was similarly mapped out. All experiments indicated that on air being inspired, a small portion was inclosed by projecting cartilage and drawn up against the upper nasal muscles which bear the olfactory nerves.

Recognition of a smell can also occur during an expiratory act. This is apparent in swallowing, which causes a certain movement of air in the mouth and nose.

Mastication and the warming of the food in the mouth act favorably upon the development of odors, and the sense of smell is so closely associated with that of taste that they are often confused. For instance, it is incorrect to speak of the sweet smell of chloroform, it is a taste; and the same is true of the acid sensation caused by acetic acid.

The loss of appetite during a cold depends in great measure on the lack of sense of smell. On chewing small pieces of apple or onion it is only when the nose is not closed that the one can be distinguished from the other. Here the supposed difference of taste is really a difference of smell.

Suggestion too may have a very important bearing upon the olfactory sense.

How the presence of an odor is actually realized is not clear. It is assumed that some of the odor-containing air passes the olfactory cavity and reaches the olfactory nerves by diffusion. Whether a direct sensation is produced there, or whether a chemical change must first take place, is equally uncertain; perhaps both occur. Nor do we know which properties of the odorous substance cause the sensation.

Although attempts have been made to connect odor with chemical constitution, the subject has not progressed beyond the initial stages.

* Reproduced from *American Perfumer*.

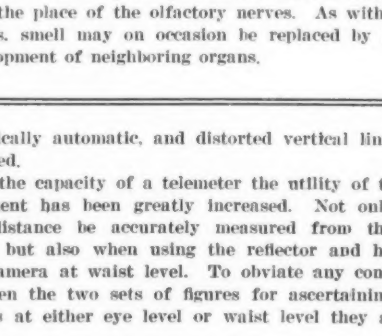
A Combined Finder, Level and Telemeter

The accompanying drawing shows the construction of a novel combined finder, level and telemeter. It is claimed for this instrument that it combines all the advantages of the older forms and offers some substantial new advantages. The camera can be leveled and the distance of the object ascertained with one observation. This observation can be made either with the camera at the eye level or at the waist. The distance can be accurately ascertained either when the observation is being made on level ground or when the object is above or below the level of the observer.

This instrument combines the functions of three separate pieces of apparatus necessary to all photographers and particularly to users of hand cameras who focus their pictures by means of a scale. As a finder it is of the direct type, showing the view in the brightest light. Its field takes in the wide angle embraced by modern lenses (except those used for purely architectural subjects) and the angle can be modified, if desired, in both directions by removable masks of varying apertures, three of which are included with the instrument. It can be used at the eye level or at waist height by inserting a mirror to look down upon. This removable mirror slips into a flat sheath which can be carried in the pocket or attached to the body of the camera.

On looking through the hole in the foresight the camera is leveled by making the top of the swinging frame hide the line in the middle of the finder lens. The slightest depression or elevation of the camera, or the least tilt to right or left, will be instantly noticed. Thus it has the unique advantage that, whereas with any other form of finder it is impossible to compose the view and watch the level at the same time, in this instrument the exact opposite is the case. It is impossible to compose the picture without noticing an inaccuracy in the level, so that the levelling becomes practically automatic, and distorted vertical lines are avoided.

In the capacity of a telemeter the utility of the instrument has been greatly increased. Not only can the distance be accurately measured from the eye level, but also when using the reflector and holding the camera at waist level. To obviate any confusion between the two sets of figures for ascertaining distances at either eye level or waist level they are so



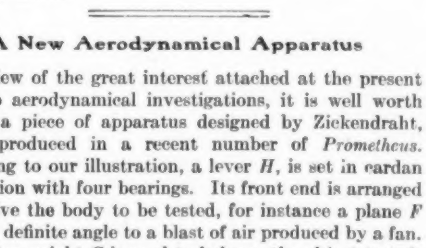
A Useful Adjunct for the Camera.

arranged that only the proper set can be read, the alternative set being seen inverted and not easily distinguishable.

The distance of objects on ground considerably above or below the operator can also be measured. In using the instrument as a telemeter for objects on the same level, the camera is first leveled in the manner previously described, and then the position of the base of the object of which it is desired to ascertain the distance is observed on the finder. From this the distance can be calculated. Two sets of figures are provided, only one of which can be read the correct way up at one time. From this set of figures the distance must be taken.

A New Aerodynamical Apparatus

In view of the great interest attached at the present time to aerodynamical investigations, it is well worth noting a piece of apparatus designed by Zickendraht, and reproduced in a recent number of *Prometheus*. Referring to our illustration, a lever *H*, is set in cardan suspension with four bearings. Its front end is arranged to receive the body to be tested, for instance a plane *F* set at a definite angle to a blast of air produced by a fan. A counter-weight *G* is used to balance the object tested.



Apparatus for Determining the Pressure Components on Aeroplane Surface.

The air pressure acting upon the surface tends to force the front end of the lever horizontally forward (to the left in our picture) and vertically upward. The two pressure components can be compensated by known forces introduced through the springs *h* and *v*, in such manner that the lever returns to its original position, as judged by a pointer and mark at the hind end of the lever. Since the springs can be calibrated directly by simply suspending known loads from them, the horizontal and vertical pressure can be read off directly from dials as indicated in our diagram.

Trade Notes and Formulæ

Disinfectant for Moving Picture Theaters.—Mix 30 parts of formalin (10 per cent) with 65 parts of alcohol (95 per cent) and 5 parts of some synthetic perfume (such as mignonette). Of this solution, 10 grammes are added to 1 pint of water and used as a spray.—*Drogenhändler.*

An Excellent Filter.—One pound cornstarch, one half pint boiled oil, one-quarter pint shellac varnish and one half pound powdered pumice stone are brought together and thoroughly mixed. For dark wood the mass may be colored if desired. Woods like ash or white oak to not require any coloring.—*Wood Craft.*

Durability of Leather.—Recent discoveries of ancient leather have been made which give a remarkable idea of the longevity of this material when properly preserved. A buried tannery was unearthed in Germany, and a number of hides that had lain in the vats for generations were found still in a sufficiently good condition to be finished and used. The great museums of Paris and London contain specimens of leather shoes that are hundreds of years old.—*Hide and Leather.*

Waterproof Glue.—1. Dissolve 20 grammes gum sandarac, 20 grammes turpentine and 20 grammes mastic in 250 cubic centimeters alcohol and mix with an equal volume of a strong, hot solution of glue and isinglass. 2. Heat on the water bath 100 parts gelatine, 10 parts glue, 25 parts alcohol and 2 parts alum with an excess of acetic acid for 6 hours, replacing occasionally the evaporating acid. Work down to a syrup consistency. This glue does not mix with water—*Der Seifenfabrikant.*

A Quick-drying Red Paint for Barrels.—Melt in a suitable kettle 20 pounds resin and stir in gradually 1 pound slaked lime; boil until the mass ceases foaming and becomes clear. Then add 2 pounds linseed oil varnish, stirring tne while and remove from the fire. Let cool down to 40 deg. Cent. Add 12 pounds crude benzole, stirring continuously and mix in 6 pounds red mineral color which previously had been ground with 3 pounds linseed oil; finally add 18 pounds heavy benzine.—*Seifensieder Zeitung.*

A Cheap Fireproof Material (for furnace or oven).—Quartz sand is strongly heated and then chilled in water; after drying it is sifted to the desired grain; 100 parts of the sand thus prepared are thoroughly mixed with 7 or 8 parts of quicklime and 3 or 4 parts of kaolin; the mass is then ready for use. Just so much of it should be mixed with water as can be used up within one to two hours; it must be applied quickly, as it binds and hardens within a short time. It is quite essential, too, that the materials used be pure.—*Der Metallarbeiter.*

Removing Spilled Liquids.—The following directions for the best method of taking up spilled oils and caustic liquids are taken from *Drogisten Rundschau:* Spilled oils of any kind may best be removed with the aid of sawdust. The soaked sawdust should at once be swept up and burned, as drying oils (such as varnish, linseed oil, poppy-seed oil, etc.) may cause oxidation and ignition. Acids are best covered with sand; for small quantities chalk may be used, but never sawdust. Nitric acid and concentrated sulphuric acid when brought into contact with sawdust will cause decomposition of the latter, forming poisonous gases of nitric oxides. Alkaline lyes, too, are best taken up with sand, excepting ammonia water, as the sand does not bind the volatile constituents of this. It is therefore necessary to first mix the sand with sulphuric acid, which will chemically combine with the ammonia fumes. Or a dish containing hydrochloric acid may be placed close to the spilled acid; but this acid should not directly be mixed with the sand, as it would cause the formation of thick clouds of salammoniac. Those engaged in removing ammonia water should cover mouth and nose with a piece of cloth soaked in vinegar.

Enamels for Precious Metals.—The following are some colored enamels for gold, silver, etc., which are fusible at low temperature.

	Flint glass. Parts.	Borax. Parts.	Metallic Oxides.
Transparent red....	30	4	Gold-purple, 0.65 gm.
Transparent blue...	34	6	Cobaltic oxide, 6 gm.
Dark blue	30	6	Cobaltic oxide, 4 gm.; bone charcoal, 4 gh.; arsenic acid, 4 gm.
Violet	30	4	Cobaltic oxide, 0.12 gm.; manganese dioxide, 4 gm.
Transparent green..	30	2	Cupric oxide, 4 gh.
Dark green	30	8	Cupric oxide, 4 gm.; bone meal, 4 gm.; arsenic acid, 2 gm.
Black	30	8	Cupric oxide, 4 gm.; ferric oxide, 3 gm.; cobaltic oxide, 4 gm.; manganic oxide, 4 gm.
White	30	6	Tin oxide, 6 gm.; arsenic acid, 2 gm.

The ingredients are fused together in the powdered state and well mixed. The enamel is ground and just before use is mixed with lavender oil and applied with the aid of a hair brush.—*Journ. f. Goldschmiedekunst.*

Electrical Notes.

Making Joints in Electric Conductors.—The following description of a simple method of making soldered joints of electric conductors is given in *Elektrische Zeitschrift.* The ends of the wires to be soldered are carefully cleaned and covered with solder. They are then put together in a copper tube, with an inside tin lining, made out of spirally wound tinned copper ribbon. The cross section of the tube exactly fits the form of the two wires to be soldered. Around the copper tube is wound a thin sheet of solder tin and around this a protecting sheet of aluminium. On the latter is placed an ignition mixture of the same kind as used in matches. This is ignited and burns quickly, and the heat thus developed causes the tin to melt so that all places between the tube and the wires are filled out. When the joint has become cold, the ash is removed, together with the aluminium sheet, and the joint is finished.

Cadmium for Tungsten Lamp Filaments.—One of the new uses for metallic cadmium is in the manufacture of tungsten electric lamps. Tungsten itself, according to the *Brass World,* cannot be successfully made into the filament by the customary method employed with other metals, of melting, casting and afterward drawing into wire. The melting point is too high to allow this to be done. In order to produce the wire in a condition suitable for the filaments, however, an intermediate process is used. Tungsten, as obtained from its oxide, is always in the form of a heavy metallic powder. This powder is mixed with an alloy of cadmium, mercury and bismuth in the following proportions: Cadmium, 42 per cent; mercury, 53 per cent; bismuth, 5 per cent. This alloy is smooth and uniform, and when heated becomes plastic so that it may readily be impregnated with tungsten powder. The two are ground together in a mortar, so that an intimate mixture is produced. The amount of tungsten used is from 30 to 50 per cent of the mixture. To obtain the wire an extrusion method is employed. The tungsten and alloy mixture is forced through a die and issues in form of a wire. The latter is then heated to drive off the alloy, after which the temperature is increased to render the tungsten solid. This latter heating is carried out in a vacuum furnace in order to remove all of the foreign substances in the tungsten.

The Acoustic Efficiency of the Telephone.—The amount of electrical energy absorbed in long telephone circuits is generally regarded as negligible, but it is nevertheless a real quantity. The telephone receiver captures only a very small proportion of the energy traversing the circuit. In a particular case Mr. W. Breisig has found that, the total energy expended in the circuit being 50 microwatts (millionths of a watt), the telephone receiver absorbed 9.2 watts, or, in other words, 18 per cent. This represents the energy which a diminutive waterfall, shedding 1 cubic centimeter of water over one millimeter head per second would give. But this is not all. It must be remembered that the major part of the 9.2 microwatts is dissipated as heat in the winding of the receiver and does not contribute usefully to the production of sound. Mr. Henri Abraham has calculated that at best the telephone does not transmit to the ear one millionth part of the energy which it receives from the line. Some years ago the minimum energy required to produce a perceptible sound in the telephone, on the supposition that the whole of it was usefully employed, was calculated. The results obtained are incredibly small. One grammecalorie would suffice to actuate for 10,000 years the membrane of a telephone so as to produce a continuous perceptible sound.—*Cosmos.*

Origin of the Names Telephone and Telegraph.—In a recent issue of *Kosmos* the question is raised as to who was the first person to use the words "telephone" and "telegraph." It appears that the origin dates back considerably farther than one would naturally suppose; the word "telephone" was applied to a simple speaking tube devised in 1838, by Dr. Romershausen. The word "telephonium" was used as early as 1828 by Sudre for an acoustic telegraph, and Wheatstone used the word "telephone" in 1831, in speaking of the mechanical transmission of sound through wooden rods. But in point of fact the word dates back a great deal farther yet. Dr. Ulmer, in the Archives for the History of Science and Industry, mentions a pamphlet published in 1796 in Berlin by G. Huth, one of the closing sections of which deals with "the use of the speaking tube for telegraphy." Huth is treating of what in his day was a great invention, namely, Chappe's optical signalling, which "he proposes to improve by posting at intervals men with huge megaphones, who are to receive and transmit the message in relay fashion, by simply speaking through their megaphones." This method of telegraphing thus was acoustic in character instead of optical, as in the case of Chappe. "This distinction," says G. Huth, "seems to demand a special name for the method of telegraphing by means of speaking tubes. What name should be better fitted than the word of Greek origin, telephone?"

Engineering Notes.

The Highest Railway Line in the World.—The highest railway line in the world is the Oraya line in Peru, running from Calloa on the coast, along the cordilleras of the Andes, to Oraza. Its total length is about 136 miles. The line rises from sea level to a height of 5,610 feet in the first forty-two miles. The Galma tunnel cuts through the mountain ridge at the highest point of the line, 17,209 feet above sea level—or 1,424 feet higher than the peak of Mt. Blanc.—*Eisenbahn Weichensteller.*

Sandblast for Testing Building Materials.—The cutting and wearing power of a stream of blown sand, long since utilized for various purposes, has been employed for testing building materials at the Gross Lichterfelde Institute in Germany. Granite, pine wood, linoleum and other substances used in construction and furnishing of buildings are subjected for about two minutes to the action of a blast of fine quartz sand under a pressure of two atmospheres. The results show the resisting powers of the substances, tested to the effects of wear. This form of test is also applicable to road building materials.—*The Engineer.*

Ferro-Cement Roads.—"Ferro-cement" roads, as stated in *Cement and Engineering News,* are being experimented with in France. This substance is made of cement mixed with iron straw. To make a slab or block of ferro cement, a mass of iron straw is placed in the mold and there is poured over it cement sufficiently fluid to penetrate into all the interstices of the iron and completely cover it. When the whole has set the core of iron thus intimately incorporated gives to the block a great resistance to breakage and traction, at the same time furnishing elasticity to compression which enables it to stand superficial shock. A brick of ferro-cement 1 3/5 inches thick has supported during crushing tests, a pressure of about sixty-five tons to the square inch. In breakage tests, the resistance was four times that of ordinary cement. Resistance to wear was no less remarkable.

Lighting by Neon Tubes.—As has long been known, a vacuum tube charged with neon gives a brilliant light with but little absorption of electric energy, yet, as with other vacuum tubes, there is a progressive absorption of the gas, and the light finally becomes extinguished. In a note presented before the Paris Academie des Sciences, M. G. Claude describes a number of experiments made to overcome this drawback. He found that with the tubes first used, having small electrodes, the latter heated rapidly, nearly to redness, and a metallic deposit formed on the glass in their neighborhood. After eight hours' working the amount of this deposit was as much as 1.6 grammes. On examining the deposit he found that neon appeared to be occluded in the metal. Since the disappearance of the gas was thus a consequence of the vaporization of the electrode, M. Claude reasoned that the life of the tube would be increased by using larger electrodes, which would keep cooler. With this object he constructed a neon tube 45 millimeters in diameter, having copper electrodes equivalent to a surface of 300 square centimeters per ampere of current. One of these tubes worked satisfactorily at the Salon de l'Automobile for 210 hours when it was accidentally broken. Since then, with a tube 6 meters long, and having electrodes presenting a surface of 500 square centimeters per ampere, M. Claude found that the potential difference necessary to maintain the current only changed by 4 per cent in 40 hours. The efficiency is stated to be excellent, being 0 watt per candle. In this connection it is, perhaps, of interest to note that, were energy wholly convertible into the light to which the eye is most sensitive, the output would be 55 candles per watt, according to recent measurements of Messrs. H. Buisson and Ch. Fabry.—*Engineering.*

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